BULLETIN 58
PAMPHLET No. 8
Revised 1963

FORESTERS' MANUAL

COMMUNICATIONS

Telephone

FORESTS DEPARTMENT
PERTH
WESTERN AUSTRALIA

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FORESTERS' MANUAL

COMMUNICATIONS

TELEPHONE

Prepared under the direction of

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Issued under the authority of the

Hon. W. S. BOVELL, M.L.A., Minister for Forests

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FOREWORD

(1) The attention of officers receiving this pamphlet is drawn to the introduction in Pamphlet No. 1 which is applicable to the Manual as a whole.

(2) It is to be noted that each section as issued will override the instructions contained in circulars on subjects covered by the section and such circulars will automatically be cancelled.

(3) In recent years some major alterations and additions have been made to the Forests Department's telephone system necessitating the re-issue of these notes.

(4) These consist of—

(a) Redesigned switchboards.
(b) Introduction of new line-jointing method.
(c) Changes in settlement line lay out.
(d) Changes in the maintenance system.

(5) Some chapters have been added to cover these alterations and additions, while other chapters dealing with theoretical aspects have been condensed to an outline.

(6) Bush telephone line construction is the responsibility of the Field Staff. Each Divisional Officer is responsible for the maintenance of communication within his Division and for ensuring that all lines are correctly constructed, in accordance with prescriptions as set out in the Manual and that a high and proper standard of maintenance is carried out. Officers in charge of Districts are directly responsible to the Divisional Officer for the efficient maintenance of circuits within their Districts. They must be thoroughly conversant with the details of construction and maintenance methods and prescriptions. They must ensure that no officers or men are sent out on construction or maintenance work unless and until they are fully instructed and are competent to do the necessary work.

(7) Maintenance and repairs to switchboards, telephones, handsets and bells is the responsibility of the Radio Branch. Extensive damage can be done by unskilled staff attempting repairs.

(8) Alterations to settlement telephone cables or switching must not be made without the authority of the Telecommunications Officer.

INTRODUCTION.

Telephone system adapted for forest conditions.

1. Telephone lines normally consist of a metallic return circuit, i.e., two wires strung on poles, strained to a specified tension and attached to skirted insulators by tie wires. Such lines throughout forest country would be liable to frequent damage and broken wires with falling trees or limbs, and communication might thus be cut at a critical time. The cost of clearing a right-of-way wide enough to avoid any falling timber would be prohibitive. Therefore, through forest areas, the Department has adopted a standard bush telephone line consisting of a single slack heavy gauge iron wire, free running through "reel" insulators, with "earth" return. With proper construction methods breaks should never occur in this type of line.

2. Standard methods were worked out in U.S.A. and Canada, where many thousands of miles of line have been in use for over 40 years and these methods have been adapted to meet the requirements of our local forest conditions.

Open country.

3. Telephone lines crossing open country and not liable to damage from falling timber may be dead-ended beyond the timbered area and then drawn taut and hung from poles using iron pins and reel insulators.

In open country such as townships and built-up areas the bush slack line should be dead-ended and continued with a taut copper line hung from poles using skirted insulators.

Coastal plantations.

4. In coastal plantations where wide firebreaks limit the risk of damage to the tree line by falling timber and where the deep sand gives a very poor earth, the metallic circuit line (consisting of two taut copper lines on poles) is more serviceable.

PLANNING THE TELEPHONE SYSTEM.

Preparation of plan.

5. Too much emphasis cannot be placed on the importance of preparing a carefully drawn plan of the entire system before starting the construction on any part of it.

6. It is of vital importance that very careful consideration be given to all probable future extensions of the telephone system when preparing this plan and to ensure that no overloading will occur with too many telephones on any one section of line.

Head Office approval required.

7. The plan should be forwarded to Head Office for approval and no construction on any part of the scheme should be commenced without the approval of a Superintendent or Regional Inspector.

Permission to be obtained from various authorities.

8. The plan should show clearly the positions of all crossings of roads, rails, power lines and private property. Permission should be obtained in writing locally by the Divisional Forest Officer from the local authority, or private individuals, where the line crosses local roads or private property. Where the line crosses W.A. Government Railway lines, Main Roads, or State Electricity Commission power lines, Head Office should be requested to obtain permission for the crossings.

9. The plan should provide for a break switch on the line in a convenient position near the Divisional boundaries for testing purposes.

10. The type of line to be constructed, the position of all phones, switch boxes, towers, etc. should be marked clearly on the plan.

STANDARD BUSH TELEPHONE LINES.

General.

11. The standard bush telephone line consists of a heavy gauge mild steel galvanised wire running through insulators suspended from tree pins.

The line is essentially slack and is free to run through the insulators, so that falling trees and limbs bring the line to the ground without breaking the wire and interrupting the circuit. A single wire only is run and the return circuit is completed by earthing the other side of the telephone instrument.

Advantages.

12. This type of line has the following advantages:—

(i) Low constructional cost and low maintenance costs.

(ii) High serviceability.

(iii) Simple and easily serviced terminating apparatus.

Disadvantages.

13. It has the following disadvantages—

(i) It is subject to induced magnetic and static disturbances from other lines (principally electric mains).

(ii) High line resistance, due to the low conductivity of steel wire.

(iii) Reduced range, due to the resistance of the earth contact and the resistance of the earth return path. This latter is variable, but can become so high in sandy coastal areas that the system is almost unworkable.

(iv) The use of "unskirted" insulators causes line leakage in wet weather, which increases the line load.

Principles of the tree line construction.

14. The essential features of a tree line are—

(i) The reel insulator supporting the line wire is attached to wooden pins which are inserted in trees instead of poles. The line may run freely in either direction through the insulator if subjected to strain.

(ii) Abundant slack is left in the line to permit it to be carried to the ground if struck by falling timber, without either breaking or pulling loose a tie wire. In appearance it is festooned from tree to tree.

(iii) The insulator is attached to the tree by a weak soft iron wire and if there is insufficient slack in the line to allow it to be carried to the ground when hit by falling timber, the soft tie wire straightens under the strain and frees the insulator, allowing it to fall to the ground with the line.

Standard wire gauges.

15. The wires used in Departmental telephone overhead lines are standardised as follows:—

(i) Tree lines through forest country are of No. 8 s.w.g. galvanised medium hard steel. (Equivalent to P.M.G. 400 lb. per mile G.I.).

(ii) Settlement or cleared telephone lines in open country are covered by para. 3. Road and railway crossings are of No. 14 s.w.g. hard drawn copper wire. (Equivalent to P.M.G. 100 lb. per mile).

S.w.g.	Material	Weight per mile	Breaking Strain	Resistance per mile	Relative cost
		lb.	lb.	ohms	
No. 8	Med - soft iron wire galvanised	400	1100–1250	15	£19 per mile £80 per ton
No. 14	Hard drawn copper	100	330	8.7	£19 10s. per mile £436 per ton

Prices are approximately those ruling in June, 1963.

16. The following is a list of tools and equipment for a 3-man gang:— Equipment.

1 light motor truck.
2 tents and 3 flies. (If camping out.)
1 only 14ft. ladder (light in weight) and 1 only 16ft. (or 17ft.) ladder.
N.B.—The higher ladder is required for boring holes for wooden pins.
1 wire jenny.
3 axes.
1 10" Millsaw file.
1 tomahawk.
2 crowbars (with one end for tamping earth round poles).
2 long handled shovels (round mouth).
1 light snigging chain—for snigging poles.
1 pair wire cutters (Bernard's Pt.).
1 pair large pliers (11" double side cutting).
1 pair linesman's pliers (8").
1 wire key (for No. 8 wire).
1 safety belt (with a leather strap extension).
1 brace and the following bits—5/16", 7/16", ½", ⅝" and ⅞", and nail bits Nos. 6 and 3.
1 sleeving tool.
100 No. 11 sleeves (for jointing No. 8 s.w.g. wire).
50 No. 3 sleeves (for jointing No. 14 s.w.g. wire).
20 adaptor sleeves (for jointing No. 8 to No. 14).
10 tee sleeves (for jointing No. 14 into a No. 8 line).
1 sleeving tool "go-no-go" gauge.
1 adjusting gauge for sleeving tool.
2 pieces 2" rope 30 feet long.

17. All aerial telephone line joints are to be made with compression sleeves, using a special press tool to make the joint. (App. A, Item 19). The two ends of the wire are pushed into a copper sleeve which has been internally sprayed with antimony. The jointing tool is then applied to the sleeves, giving it 4 to 6 squeezes. This forces the sleeve metal into close union with the line wire, producing a nearly perfect joint with a conductivity of 98% and a mechanical union strength of 95%. Jointing the line.

18. The sleeves types used are as follows:— Sleeve types.

(i) For jointing No. 14 s.w.g. copper wire—
Sleeve No. 3.
Groove Size 3/16".
Wire diameter 0.079".

(ii) For jointing No. 8 s.w.g. galvanised iron wire—
Sleeve No. 11 b).
Groove Size 5/16".
Wire Diameter 0.160".

(iii) An "adaptor sleeve" is used to join a No. 8 s.w.g. G.I. to a No. 14 s.w.g. copper, i.e., when crossing a road or a railway line.

(iv) A "tee sleeve" is used to branch from a No. 8 s.w.g. G.I. line without cutting the line, the branch line being No. 14 s.w.g. copper.

19. To make a joint of the required strength, the procedure should be as follows:— Making a joint.

(i) Lightly scrape the wire with the **back** edge of a knife to clean it.

(ii) Push the wire ends into the sleeve until they butt against the dent in the middle of the sleeve.

(iii) Give No. 3 sleeves two squeezes each end and No. 11 (b) sleeves three squeezes at each end. To keep the sleeve from curving, make each squeeze at 180° rotation.

20. The jointing tool must be adjusted daily with a gauge, as set out in the instructions issued with each tool. The tool should be kept clean and lubricated and an empty tool should work freely with a slight spring when fully closed. Care of the jointing tool.

The adjustment screw is set so that when the tool is closed a sample joint can pass freely through the "go" gauge, and not through the "no-go" gauge.

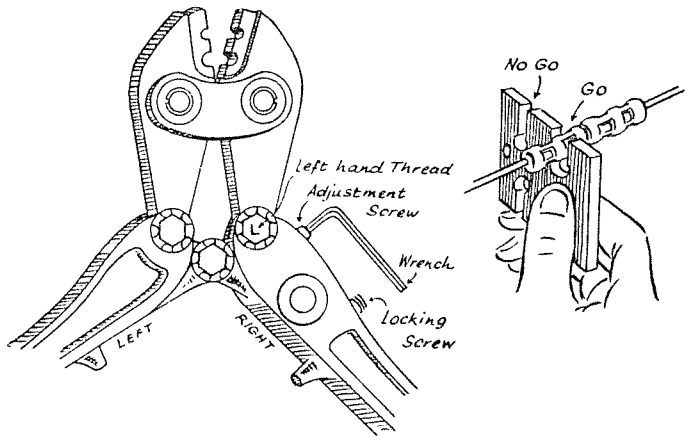


Fig. 1.

Breaking the wire.

21. The wire should not be cut with wire cutters, pliers, etc., as the ends burr and will not enter the jointing sleeve. Instead, the wire should be filed one-third of the way through and then broken between the fingers and thumbs of both hands. This will give a clean break.

Successful tree line construction.

22. The six important points for successful tree line construction are:—

(i) A slack line wire.

(ii) Equalised spans between trees.

(iii) Weak ties.

(iv) Standard installation methods.

(v) As few sharp turns in the line as possible.

(vi) The line wire 17ft. above the ground at the insulators.

Selection of the route.

23. After the objective points have been determined, the route is selected on the plans and a preliminary field reconnaissance made to ensure that the following conditions are fulfilled:—

(i) The line should follow close to, and not more than 1 chain from the road or track clearing and should be easily visible from the road. This facilitates inspection and simplifies construction and maintenance. Any obstruction on the line is quickly located.

(ii) It should not cross and re-cross a road, or cross a railway unless unavoidable.

(iii) It should be located to minimise trouble from ring-barked or falling timber.

(iv) It must not parallel existing telegraph or telephone lines, as cross-talk will generally arise if a ground line parallels either a ground or metallic line closer than 30ft. for a distance of one mile.

(v) Electric light, power and high tension transmission lines should be avoided altogether, if practicable, by making a detour and any crossing must be made at right angles.

Note.—Severe hum induction will result if telephone lines are run at a distance of less than 30 chains from a high tension transmission line. It may be possible for a telephone line to pass under a high tension line

at right angles with a tolerable amount of hum induction, but it is advisable to instal a temporary line and test the amount of hum induction first.

(vi) Rocky stretches and bad swamps should be avoided by a detour, rather than incur extra expense in blasting for pole foundations.

(vii) Sharp angles should be avoided as far as possible. The route should be selected in the general direction of bush tracks and should not follow the crooks and sharp turns. See fig. 2.

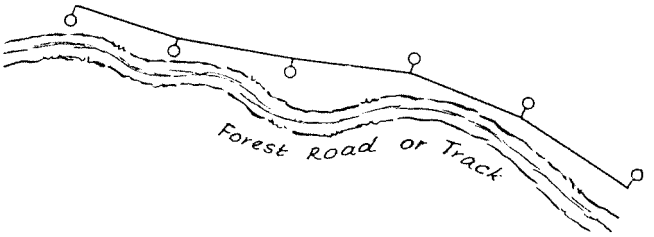


Fig. 2.

Selection of tie trees.

24. The careful and judicious selection of tie trees is of the utmost importance, as on this depends the whole success of the line. Sound trees should be selected of sufficient diameter to minimise sway—generally not less than 6" diameter at 17ft. The course of the line may be varied slightly to take advantage of desirable trees. An officer will select the trees and lightly blaze them fore and aft on the side on which the wire is to be hung.

Length of span.

25. A span of 2 chains should be aimed at, but should not be less than 38 yards, or greater than 50 yards. It may be necessary in exceptional circumstances to have a span as short as 33 yards, but it should never exceed 50 yards, as the slack accumulates in the long spans, bringing the wire dangerously close to the ground. If this occurs, the officer or linesman invariably strains the line tighter to give adequate clearance in the long span. This immediately defeats the whole object of obtaining a "slack" line with plenty of "play" in it.

Equalised spans.

26. Spans should be equalised as far as possible and abrupt changes in lengths of adjacent spans must be avoided.

Tie trees "staggered."

27. The tie trees should be "staggered," i.e., out of alignment, so that the pull of the wire is **away** from the tree, allowing the insulator and line wire to swing clear. Stagger of 6 ft. to 8 ft. is ideal, but may vary from Nil. up to 15 ft. in 40 yard spans, or Nil. up to 18 ft. in 50 yard spans. Excessive stagger should, however, be avoided as far as possible.

Negotiating angles.

28. Angles in the line can usually be negotiated by taking the stagger on the same side of successive trees without exceeding the figure of 15ft. or 18ft. given in the preceeding paragraph. See Fig. 3a.

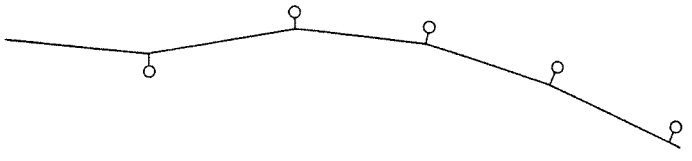


Fig. 3a.

Negotiating sharp angles.

29. If a sharp angle is necessary at one tie tree, a "fixed" tie should be made instead of the usual slack tie, to prevent the line pulling away from the tree under excessive strain. See Fig. 3b.

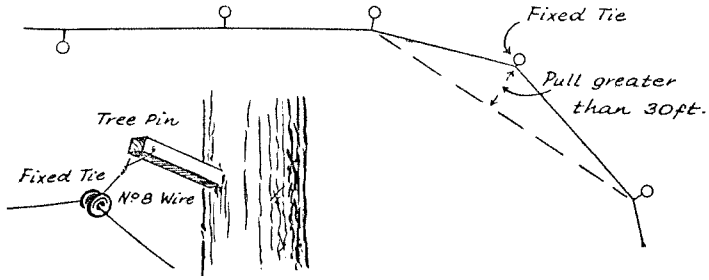


Fig. 3b.

30. A still sharper angle, i.e., anything less than 145 deg. should have a double insulator tie. See Fig. 4.

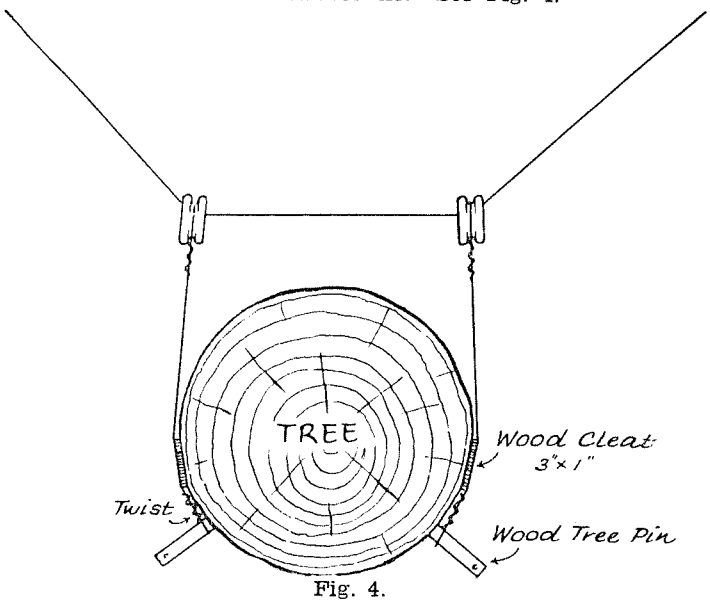


Fig. 4.

Alignment systems.

31. Two systems of alignment may be followed—

(i) The trees are selected to give a regular zig zag course. See Fig. 5 (a).

(ii) The trees are selected to give a series of reverse curves. See Fig. 5 (b).

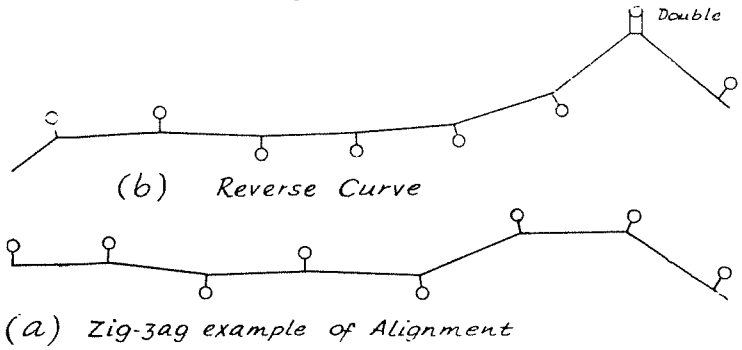


Fig 5.

32. In practice a combination of both systems is used to obtain sufficient tie trees, so placed that the line is always pulling **away** from the trees.

33. A **slight** pull towards the tree is not serious, provided the tie wire is not strained at an acute angle towards the tree. However, only in exceptional circumstances should this be done, and then only with the approval of the Divisional Forest Officer.

Use of poles in poorly stocked forest.

34. Where trees do not occur to fulfill the conditions of spacing and stagger, poles must be erected. As many as 12 poles per mile may be required in a poorly stocked forest, and as few as one or two in a well stocked forest. Marking stakes should be set where each pole is required.

Clearing the route.

35. Following the blazing of tie trees and erection of pegs where poles are required, two or three men will follow and clear scrub, saplings, overhanging trees and limbs that would come within 2 ft. of the line. Small trees that would grow over the line and snags likely to fall on it must be removed. In sighting from tree to tree for the cleared right-of-way, it must be remembered that the line is hung from about 17 ft. and stands out some 8" from the blazed side of the tree.

Minimum falling.

36. As dense coppice growth from stumps quickly grows up to the line, it is preferable to prune branches from trees, rather than fall the trees. Felling of trees and saplings should be kept to the minimum required to give the line adequate clearance from standing trees.

Erection of poles.

37. Poles may be cut and erected at each pegged site by the clearing gang as it proceeds, or by additional men if a larger gang is operating. Normally one man can sink a hole, while two are cutting, barking, trimming, wiring, boring and snigging-in a pole, so that the three men may erect and tramp it in immediately before proceeding along the line. The truck with necessary equipment is brought ahead by stages as clearing proceeds, so that it is always handy when a pole is to be cut and erected.

Clearing length and organisation of work.

38. **Construction** is most efficiently done by a 3 man team, and **maintenance** by a 2 man team. If for any reason, more than 3 men are employed, the Officer in Charge and Overseer must ensure that the details of work are so organised as to keep all hands usefully occupied throughout the day, otherwise costs will soar to an excessive figure.

It is advisable to clear from 3 to 6 miles of line and erect all poles required on such before commencing to hang the wire.

Burning of debris.

39. When in clearing through a line any accumulation of debris results, the officer responsible for the construction of the line must make immediate arrangements for its disposal by means of controlled fire. If there is the slightest danger of such fire spreading, the Forester in Charge of the District should be consulted and the burning carried out under his direction. In certain cases the small amount of lop and top resulting from falling will not burn until some months later. In such cases the necessity for this debris to be burned at the first opportunity should be brought under the notice of the Forester in Charge of the District.

Unreeling the wire.

40. The wire should be pulled out from a wire jenny or home made reel by two men, using if available, buffalo grips for convenience. The second man follows about 8 chains behind the first and a third man remains at the reel to prevent the wire becoming kinked or tangled. A good deal of time and trouble is saved if he signals to the man by tapping the wire to a pre-arranged code, indicating "stop," "carry on," "go back," etc. The wire must not be pulled over sharp rocks, as this will remove the galvanised covering and cause rapid deterioration. At this stage the required number of insulators should be threaded on to the line.

Attaching the wire to tree.

41. The operator is strapped to the tree with a safety belt and bores a hole in the tree 17ft. above the ground with a brace and $\frac{7}{8}$" bit for the pin. Wooden pins must be used in growing trees. In dead timber or poles a $\frac{1}{2}$" bit is used for the $\frac{1}{2}$" square standard wrought iron tree pin.

Attaching insulator to pin.

42. The tie wire is cut into lengths of about 30" and tightly wrapped twice around the insulator. The projecting ends, which should be of equal length are twisted tightly together with three or four turns of the pliers. Sufficient wire is then left free to provide a shank about 8" long, the end 3" being passed horizontally through the opposite sides of the tree pin and gently bent down. See Fig. 6 The insulator with the line through it and the tie wire around it is handed to the man on the ladder to attach to the pin. See Fig. 7.

Fig. 7.

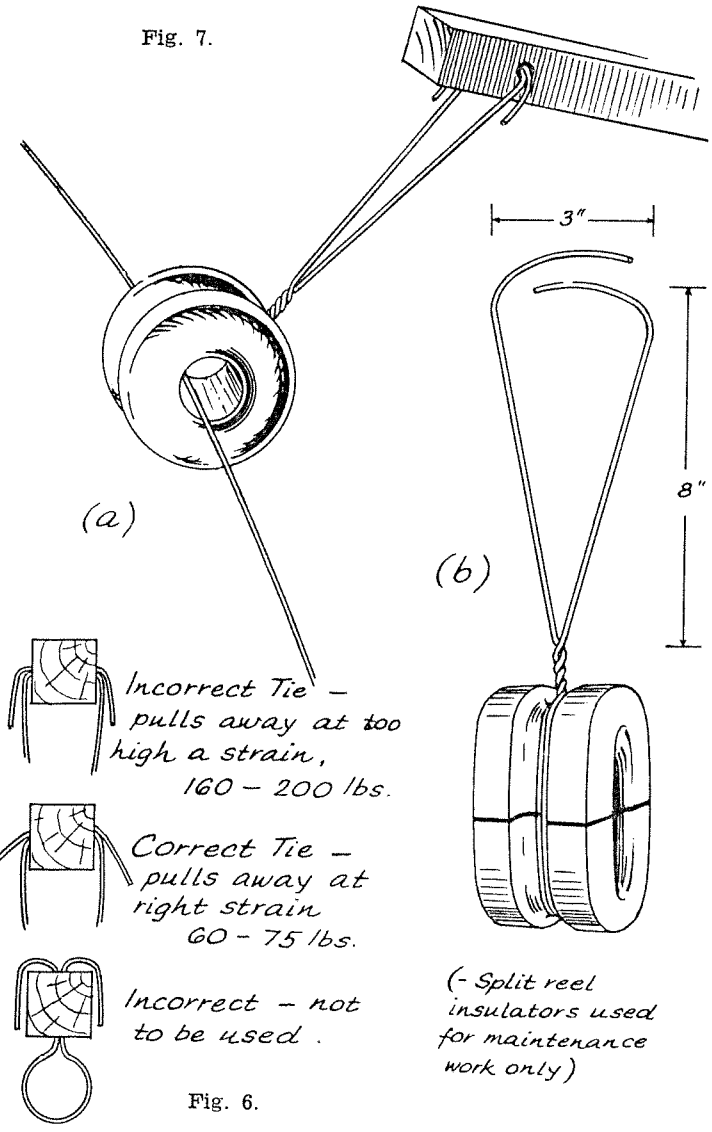


Fig. 6.

Pulling slack and running a single length.

43. When one coil of wire has been erected, one man will pull it to the required tension by hand. The wire should be alternately pulled and slackened once or twice to allow the

slack to adjust and distribute itself along the length of the wire. The end is then hitched around any handy log, tree or stump. As much slack as possible should be left in the line without allowing it to sag low enough to be dangerous. A clearance in mid span of 10ft. should be a minimum.

The following figures will serve as a guide—

Length of span	*40yds.*	*45yds.*	*50yds.*
Sag	3-4ft.	Abt. 5ft.	6-7ft.
Height of line at tree	17ft.	17ft.	17ft.
Clearance at mid span	14-13ft.	12ft.	11-10ft.

The line should have an average span of 2 chains, an average sag of 5ft. and an average clearance at mid span of 12ft. A down pull of 35 to 50lbs. in the middle of a span should bring the line to the ground.

To hold the wire from running back, a short cross tie is twitched on the line wire at the last insulator. See Fig. 8.

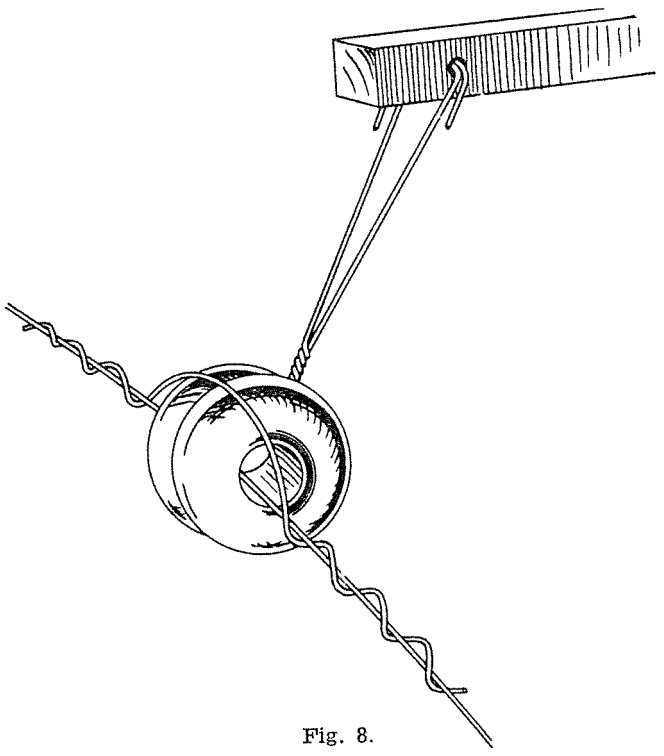


Fig. 8.

The end around the stump or log is then released and joined to the rear end of the next coil of wire after this next coil has been run out and the required number of insulators threaded.

Final clearing.

44. As two men erect the next coil, the third man will return over the last length of line and see that it is free of all obstructions. He should ensure that the sag is right and should carry out any final clearing required. He will also remove the previous cross tie and bring the second ladder up to the last cross tie. He will then go ahead with the truck and jenny and prepare to unreel the next coil or sink any post holes required.

Dead ends.

45. Lines will be dead ended only where necessary, as at—

(i) Either side of a railway or public road which has to be crossed.

(ii) Terminals of a line.
(iii) Either side of spans exceeding 160ft. if such spans are necessary to cross a river or gorge.
(iv) The top of very steep slopes where the strain may be too severe for the ordinary tie and where slack may accumulate at the bottom of the slope.
(v) A branch line connection to the main line.

The method of dead ending is illustrated in Fig. 9.

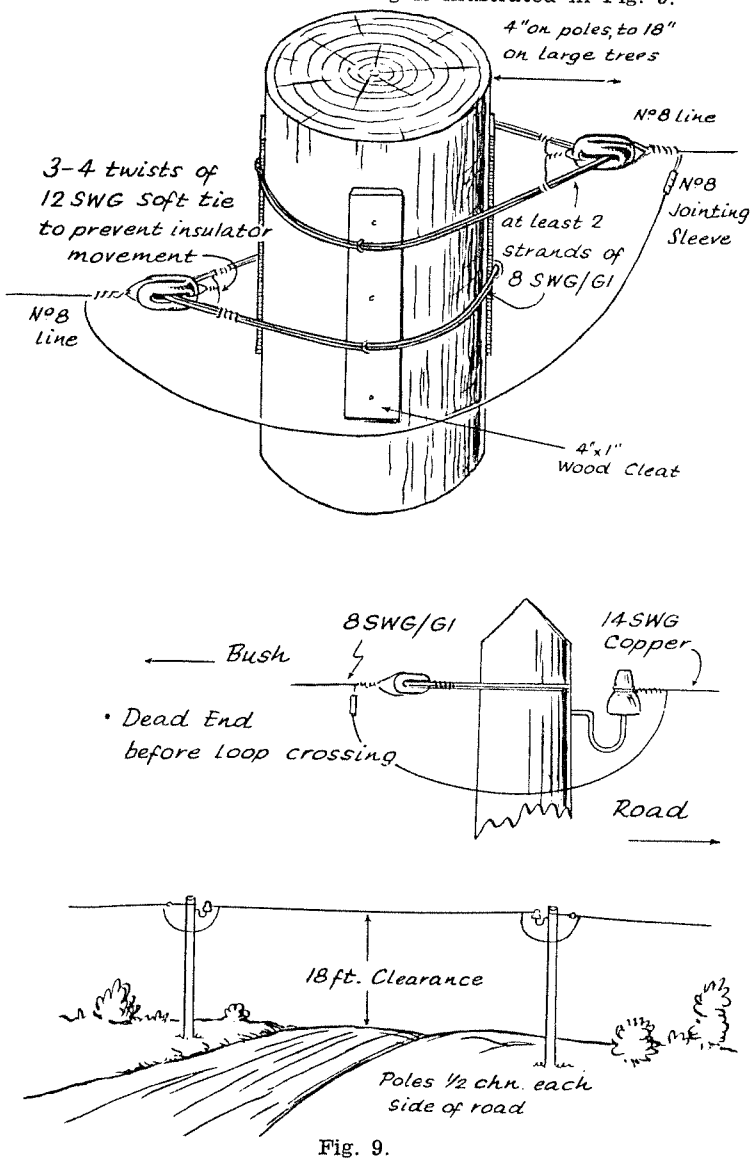


Fig. 9.

Dead-ending on poles.

If a good sound tree is not available for dead ending, a pole must be set and braced or stayed to take the strain of the line. On poles, protecting cleats will be omitted and the "fore space" reduced to 3".

For dead ends of tree lines, prior to using copper wire for road or railway crossings, a well-stayed pole should be used, and so placed in an opening that no overhead timber can fall on the relatively vulnerable copper crossing.

Poles.

46. As explained previously, a number of poles will be required where suitable trees do not occur. The ordinary reel insulator is attached in the usual way to a wrought iron tree pin driven into a ½" hole about 6" from the top of the pole. —As with trees, the wire must not pull towards the pole.

Specifications for poles.

47. Only jarrah or wandoo poles are to be used and they must be reasonably straight and free from dry rot or other defects affecting their durability. The poles should be 21ft. long, with a top diameter of not less than 6" (including sap wood). The base is cut off square and sap wood is removed to a height of 5ft. from the base. The top of the pole is cut to form a right angled roof and is securely bound with No. 8 wire with a "Queensland twitch." See Fig. 10.

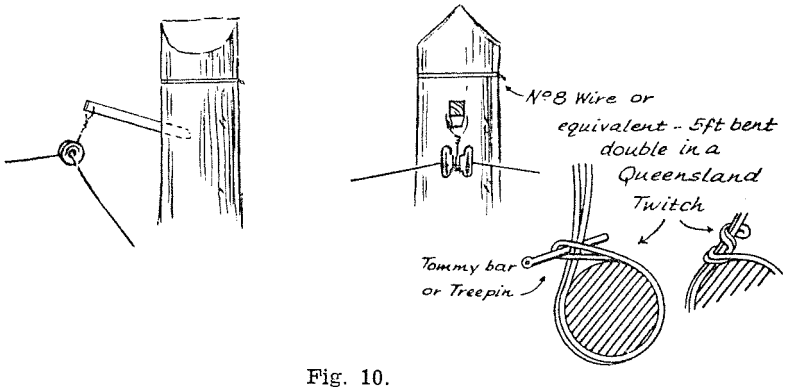
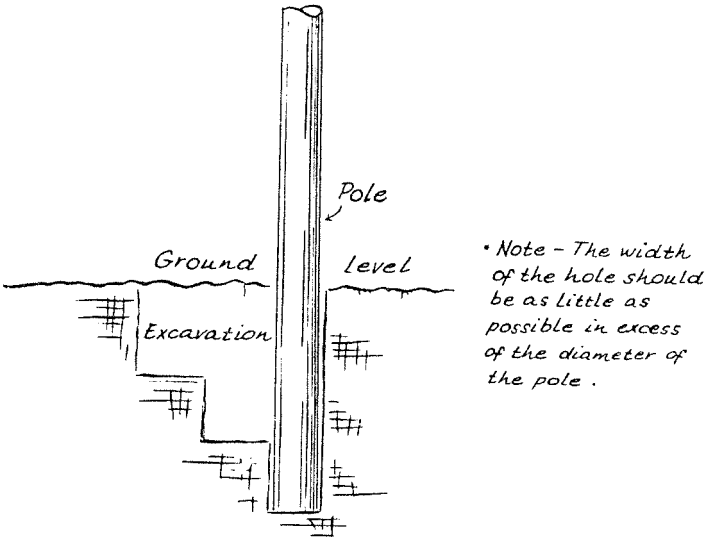


Fig. 10.

Digging holes.

48. Holes at least 6" larger in diameter than the butt of the pole should be sunk with vertical walls on three sides. The up-hill side should have a sloping wall to facilitate lifting and erection of the pole. See Fig. 11. The depth shall be 4ft. When filling in the hole, the earth should be thoroughly trampled down. If rock is encountered at a shallow depth, a cairn of stones may be built around the base and the poles stayed, or holes may be blasted out.



Erection of poles.

49. Poles are easily erected by two or three men if a 6" board is placed at the back of the hole to receive the butt and guide it down. The pole is "trued" after about 6" of earth has

been trampled around the base and the hole is then filled in and the soil packed down. About 6" of earth should be closely packed around the pole above ground level.

Railway and main road crossings.

50. Where the line crosses a railway, the specifications submitted by the W.A.G.R. must be rigidly adhered to. These are—

(i) Wires must not be less than 22ft. above the metals.
(ii) The span across the railway must not exceed 3 chains.
(iii) Wire not heavier than 14 gauge copper must be used over the line and terminated on each side with approved insulators and adequately stayed poles.
(iv) Poles must not be closer to the rails than their overall length.

Road crossings will be the same type, except that the clearance over the road surface must be 18ft.

Longer poles.

51. Poles longer than the specified 21ft. will be required for these crossings. In these cases the depth of the hole should be as follows:—

Overall length of pole	*Depth of hole*
22ft.	4ft.
25ft.	4ft. 6in.
30ft.	5ft.
35ft.	6ft.

Any poles erected with an overall length of 24ft. or more should have tree pins driven into them to serve as steps, as shown in Fig. 12. A single ladder of standard length may then be used for all work on the pole.

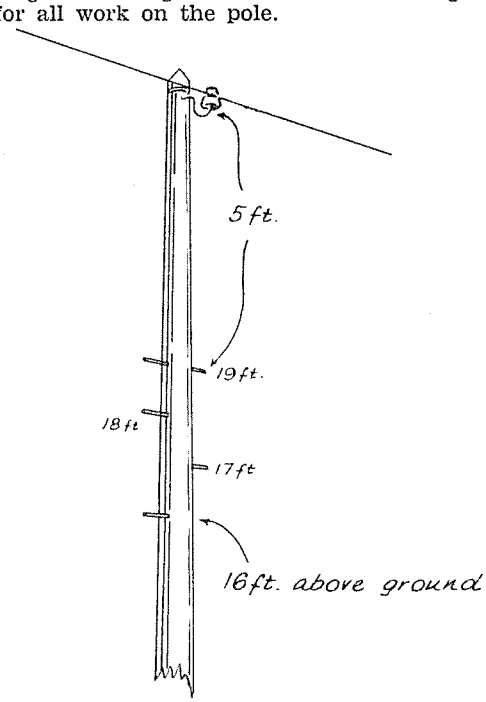


Fig. 12.

52. On curves or angles the poles may be raked to off-set the pull, but with the slack tree line this is not necessary, unless the pull exceeds 15ft. See Fig. 13.

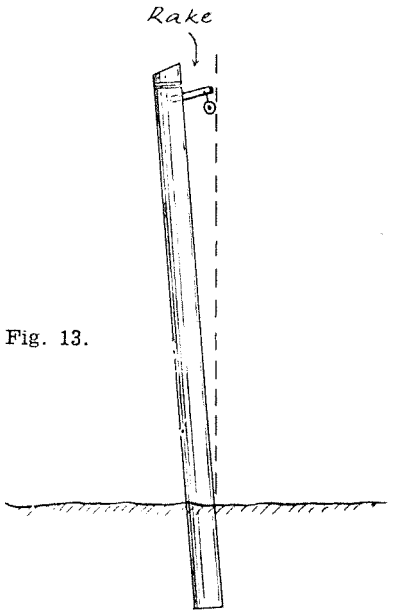
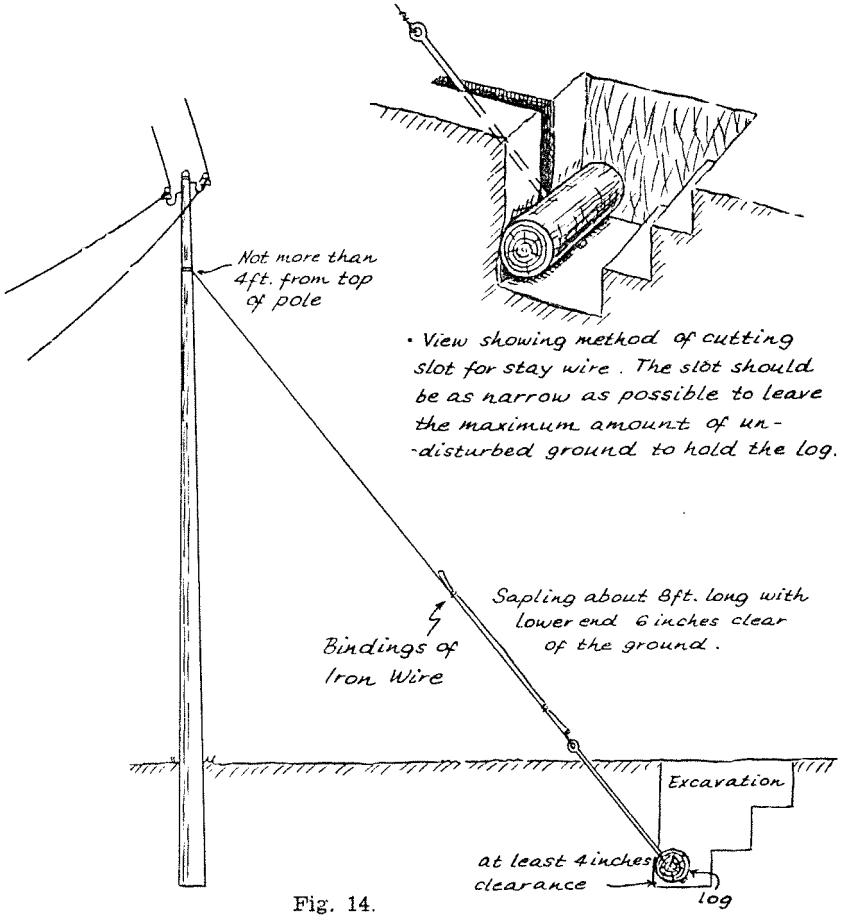


Fig. 13.



• View showing method of cutting slot for stay wire. The slot should be as narrow as possible to leave the maximum amount of un-disturbed ground to hold the log.

Fig. 14.

Stays.

53. Poles will be stayed—

(i) Where the angle is such that the pull exceeds 36ft.

(ii) On each side of a main road or railway crossing.

(iii) Where necessary on swampy or rocky ground.

(iv) Where the line terminates on a pole.

The method of staying is illustrated in Fig. 14.

To obtain a good tight stay, one man should hold the anchor log about 4" to 6" above the bottom of the trench by means of a guy rod, while another twitches the lower end of the guy wire to the loop in the guy rod. As the anchor log is then dropped back in the trench and earth filled in on top of it the guy is pulled taut.

DOUBLE WIRE OR METALLIC RETURN CIRCUITS.

General.

54. Where lines are to be constructed in clearings such as settlements, townships, coastal plantations, etc., where there is no danger from falling timber, the Standard Bush Telephone line is replaced by the metallic return circuit line supported by poles.

Type of wire.

55. As described earlier the wire to be used in this type of construction is No. 14 s.w.g. hard drawn copper wire.

Sinking holes and staying poles.

56. The methods for sinking holes for poles and for staying poles at angles and dead ends are the same as those described for the Standard Bush Telephone line.

Swan neck spindles.

57. The line is attached to skirted insulators which are held by swan neck spindles, one on each side of the pole. See Fig. 15.

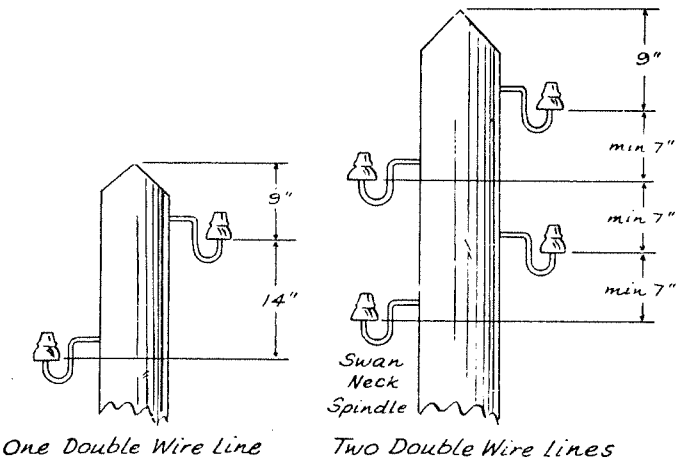


Fig. 15.

Where possible a space of at least 12" is desirable between insulators, but this may be reduced to 9" where the distance between poles is less than 2 chains, as happens within a settlement.

58. The wire should be fastened on the "pole" side of the insulators, except where the line changes direction and it should then be fastened so as to pull towards the insulator. See Fig. 16.

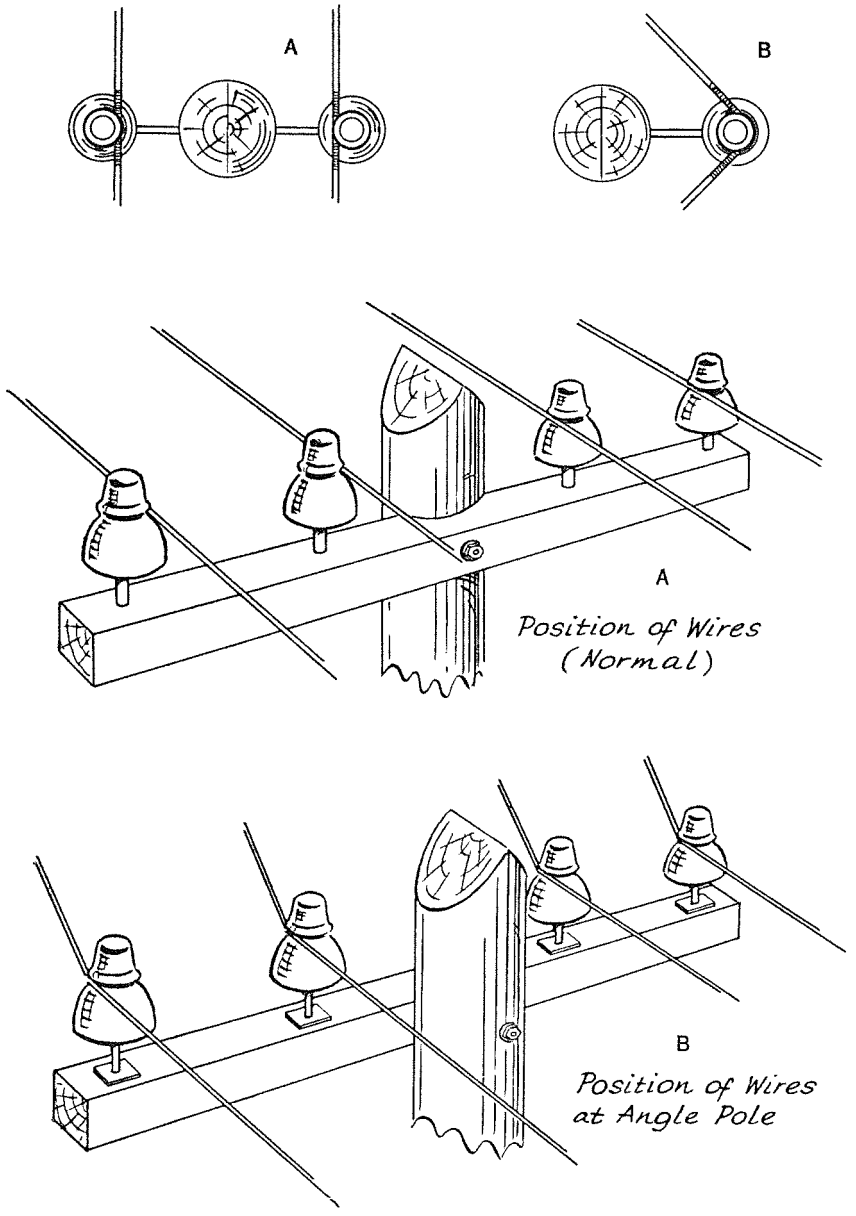


Fig. 16 (a) and (b).

59. Fig. 17 indicates the method of attaching the wire to the insulator. When dealing with copper wire extra care must be taken to ensure that the wire is not damaged by scratching or nicking, otherwise the wire will break. Tie wire in this case should be No. 14 s.w.g. line wire, **softened by fire.**

Attaching line wire to insulator.

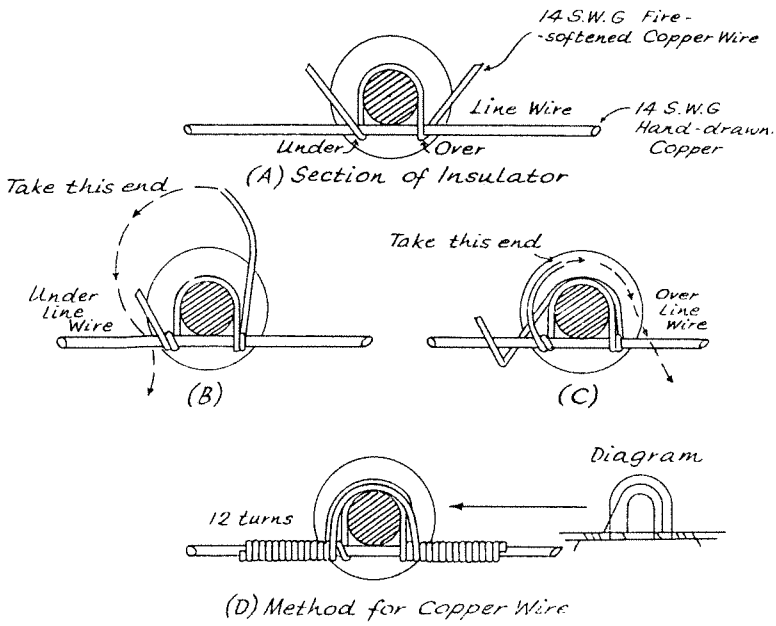


Fig. 17.

Terminating a line.

60. Fig. 18 shows the standard method of terminating a taut copper wire.

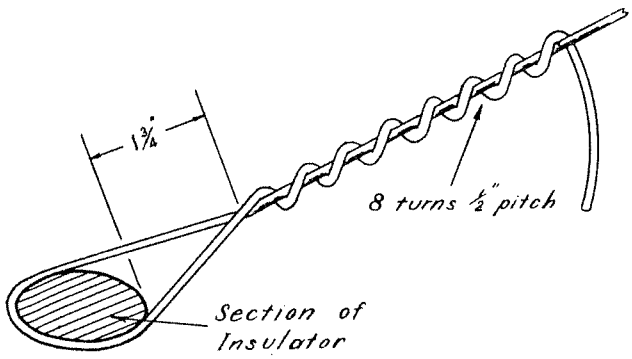


Fig. 18.

Tensioning the line.

61. The tension of 100 lb. per mile hard drawn copper telephone wire should be as follows:—

Sag for Copper Wire.

Temperature	55 yd. span.	66 yd. span.	77 yd. span.	88 yd. span.
50 F	9″	13″	17″	21″
70 F	11″	15″	19″	24″
90 F	13″	18″	23″	28″
110 F	15″	20″	26″	32″

Buffalo wire strainers should be used for tensioning. See Fig. 19.

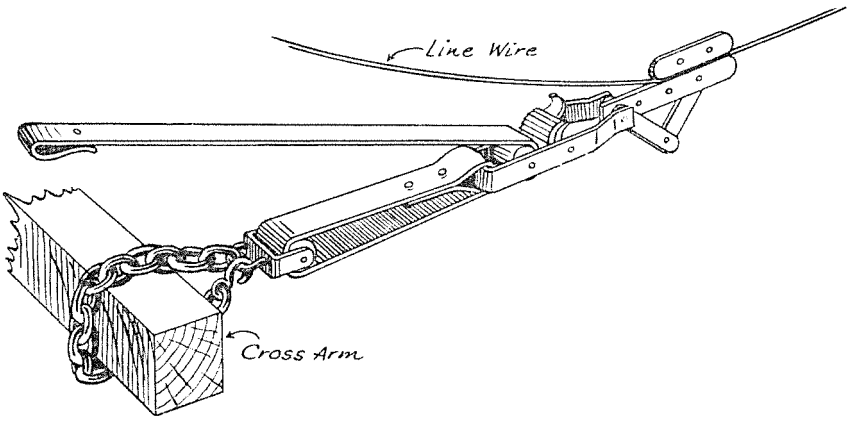
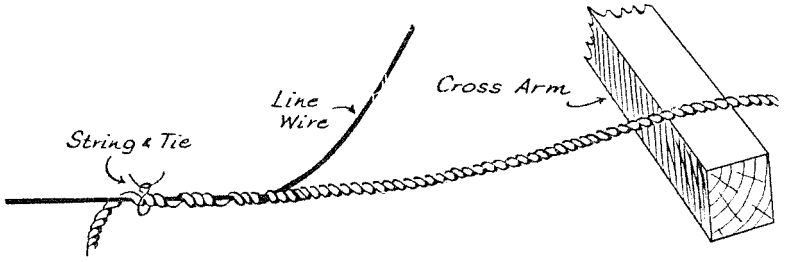


Fig. 19a and b.



Alternative method of using rope instead of buffalo grip

The wire will be damaged if strained through insulators at an angle to the line. A man must be placed at angled insulators to ease the pulling up strain at these points.

LINE CONSTRUCTION WITHIN A SETTLEMENT.

62. The bush telephone lines should be so routed that they muster at one point on the settlement boundary. Here each line is terminated with a dead end.

63. At these dead ends a conversion is made from No. 8 s.w.g. G.I. wire to No. 14 s.w.g. hard drawn copper wire and the copper lines are taken through the settlement on skirted insulators mounted on cross arms and poles.

64. The route through the settlement is generally via the back fences of the dwellings to the office or building in which the main switchboard is installed.

Straining wires on cross arms.

65. The copper lines are tensioned as described previously, to keep them well clear of settlement activity, but it should be noted that care must be taken when straining wires on cross arms as the cross arm will tend to twist. This can be prevented by atacching a temporary stay to the ends of the cross arm and temporarily anchoring it to stakes driven in to the ground.

66. Poles should be 14 ft. or more high, with 3" x 3" cross arms and wire spacing 12" or 16". Cross arms should be treated with a protective coating of paint, such as red lead, and should be stayed rigidly with galvanised iron straps. End and corner poles should be back stayed to prevent any movement due to wire straining, as it is impossible to correctly tension lines unless staying is well done.

Insulators.

67. The insulators on corner poles should be fitted with $\frac{1}{2}$" steel pins for mechanical strength.

Terminating poles should be fitted with "J" bolts. See Fig. 21.

All other insulators along the line should be fitted with wooden pins.

House lines.

68. To facilitate line testing, bush telephone lines must not be tapped directly for house connections but should be brought directly through the settlement to the main switchboard, which is usually located in the office. From this switchboard another set of lines, one for each bush line, is run around the settlement to give Officers' houses the full bush telephone facilities. By simply removing the switchboard fuse in any line a separation can be made between the settlement and bush line system for the purpose of testing.

Settlement line.

69. A separate line should be run to those houses on the settlement requiring a connection to the telephone system. This is known as the "settlement line". It enables local calls to be made without occupying time on a bush line. The settlement line should not be run more than a mile from the settlement, although it may be an advantage to connect a lookout tower situated within two miles of a settlement.

When it is necessary for any lines within the settlement to cross other overhead wires, this should be done at right angles but settlement lines should never pass under radio aerials used for transmitting or receiving purposes.

Cross arms.

70. When more than two wires are to be erected, cross arms should be fitted to the poles and straight spindles used to support the insulators. Fig. 20 shows the method of attaching cross arms to poles. Cross arms may vary in length from 3ft. to 9ft. to cary from 2 to 14 wires. For uniformity and good appearance, cross arms on the same pole and on the same line of poles should all be the same length, but on branches from the main line where fewer wires are to be carried, the length of arms may be reduced.

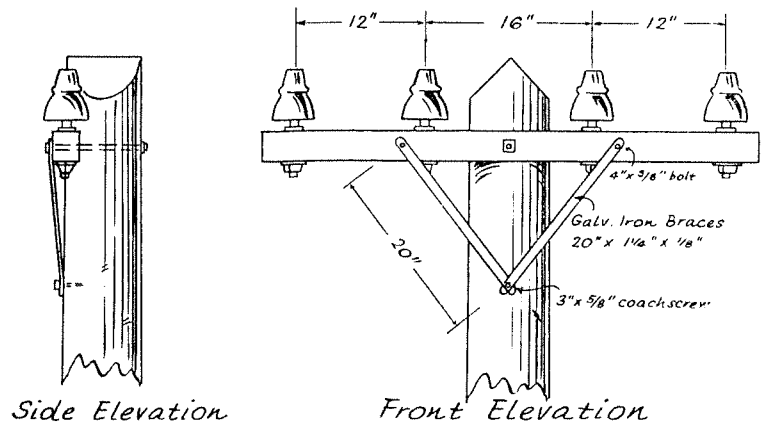
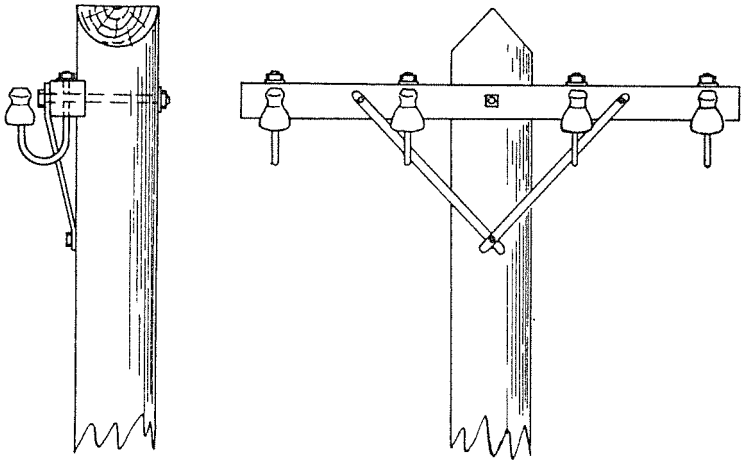


Fig. 20.

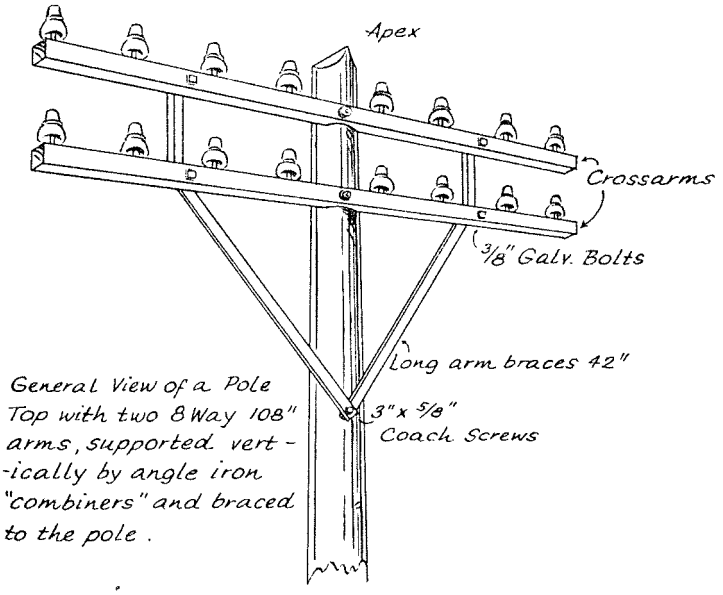


"J" Bolt Termination

Fig. 21.

71. Cross arms should be of sound seasoned hard wood 3" x 3" in cross section and of the length required. They should be suitably bored to take the required number of insulator spindles.

To provide for the cross arm the poles should be slotted to a depth of from 1-1½" and the cross arm should be secured to the pole with a ⅝" bolt as shown in Fig. 22. A coach screw 3" x ⅝" should be used to attach the braces to the pole unless there is a second cross arm, in which case the bolts of the bottom cross arm can be used for the braces attached to the upper cross arm.



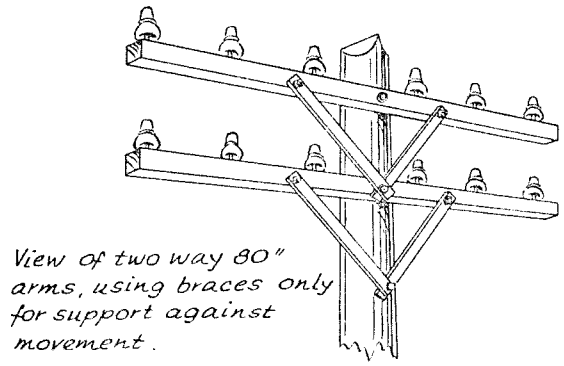


Fig. 22.

LINE TESTING.

Line testing.

72. The introduction of compression sleeves for line jointing, has simplified testing, as lines can be cut and re-jointed with minimum effort.

Procedure for testing bush telephone lines.

73. The following procedure should be followed when testing bush telephone lines:—

(i) Proceed to the approximate centre of the line and cut it. Test each of the cut sections with a portable phone to determine the faulty half section.

(ii) Re-joint the line and proceed to approximate centre of the faulty half and cut and test as before.

(iii) Re-joint the line and walk the faulty section, one man from each end.

It may be necessary to repeat (i) and (ii) if the section is too long, as in Fig. 23 where the length of line is 20 miles long and three cuts are made, leaving only $1\frac{1}{4}$ miles for each man to walk.

This method of fault finding is positive and is preferable to following hunches.

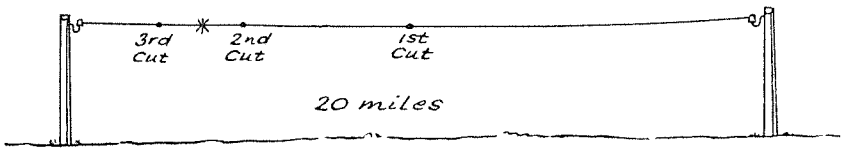


Fig. 23.

BOUNDARY AND BRANCH SWITCHES.

74. Testing and maintenance of bush lines can be simplified by fitting these switches in the line at strategic positions.

They consist of small pieces of insulation panel on which are mounted terminals and connectors capable of various line switching combinations.

75. The name "Boundary" was given to these switches as they serve the purpose of quickly disconnecting lines on Divisional Boundaries to establish in which Division the fault occurs.

Function of boundary and branch switches.

76. The functions of boundary and branch switches are:—

(i) to connect a branch (one line) or a loop (2 lines) from a tower into a main line. (In winter the branch or loop line may be disconnected from the main line and earthed in order to reduce the line load.)

(ii) To break a Divisional line for testing purposes.

(iii) To provide terminals for portable telephones.

Using boundary and branch switches.

77. When used for a branch line, connect as follows:— Refer to Fig. 24.

Main line is broken and connected to B and C.

Connect the tower line to A.

Summer connection—Tower in circuit

Link 2, 3 and 4.

Winter connection—Tower out of circuit and line earthed.

Link 3 and 4.

Link 1 and 2.

Connections for a loop line are as follows:—

Main line is broken and ends connected to B and C.

The two lines from the tower are connected to A and D.

Summer connection—Tower in circuit

Link 2 and 3.

Link 4 and 5.

Winter connection—Tower is out of circuit and the 2 lines earthed.

Link 3 and 4.

Link 1 and 2 and 5.

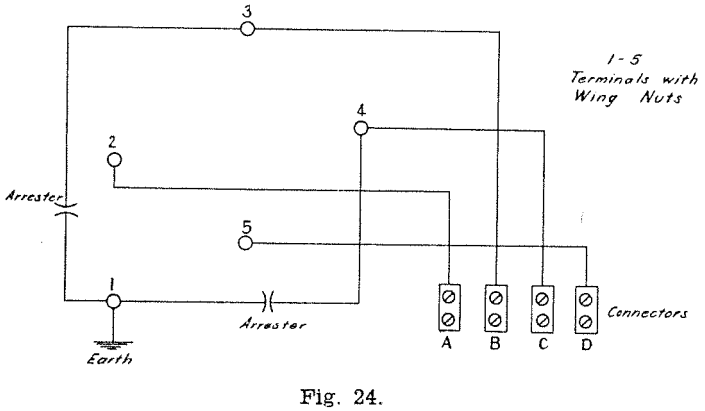


Fig. 24.

When the switch is placed on the Divisional boundary to act as a boundary switch, connect as follows:—

Break line and connect B and C.
Link 3 and 4.

To test with a portable phone:—
Open link connecting 3 and 4.
Connect phone to 1 and 3 and test call.
Then connect phone to 1 and 4 and test call.

Note.—Terminal 1 is the earth connection.

Installation of a boundary and branch switch.

78. Fig. 25 shows the method of installing a boundary and branch switch. It should be noted that the box and cross arm are to be painted a bright yellow so that they can be picked out with ease.

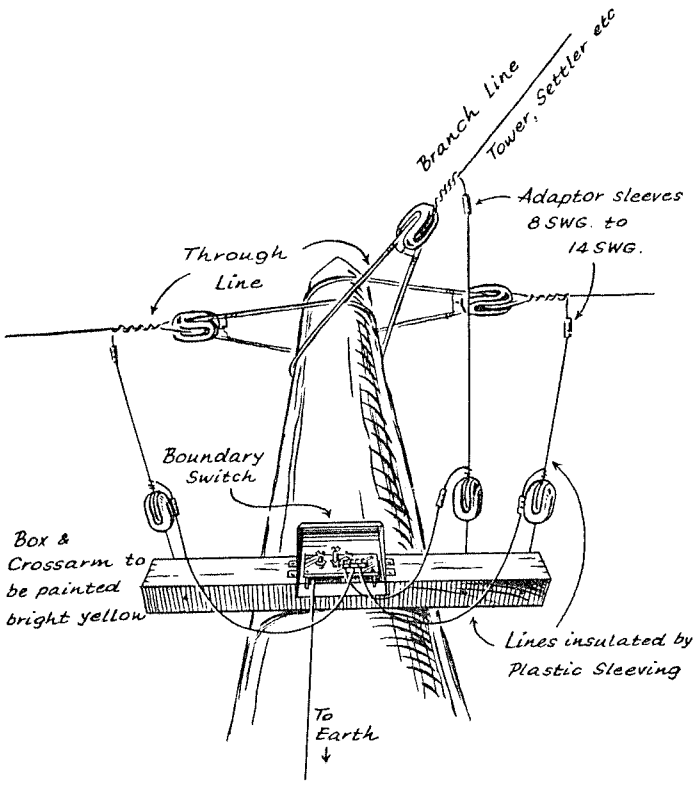


Fig. 25.

LINE TRANSFORMERS.

79. In certain districts where it is impossible to reduce A.C. interference to a reasonable level, a system has been devised which greatly improves the signal to noise level.

The principal aim is to arrange the settlement installation so that A.C. "hum" cannot be introduced anywhere in the settlement.

Where transformers are used.

80. The following is a brief description of the system:— Well clear of the settlement each incoming bush line is terminated in an "unbalance to balance" transformer (see Figs. 26 and 27).

Description of the transformer system.

Each line now becomes a pair of cables and being "balanced" may be bunched and run via underground or overhead cables to the office and settlement switchboards.

It will be noticed that once within the settlement, earth wires are not required so the chances of hum induction are minimised. Each line, of course, has an earth at the transformer which is purposely sited well clear of the settlement and of power lines and buildings.

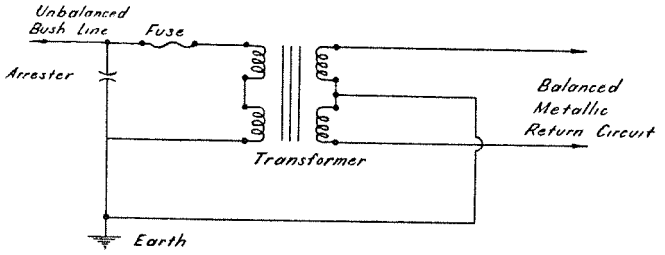
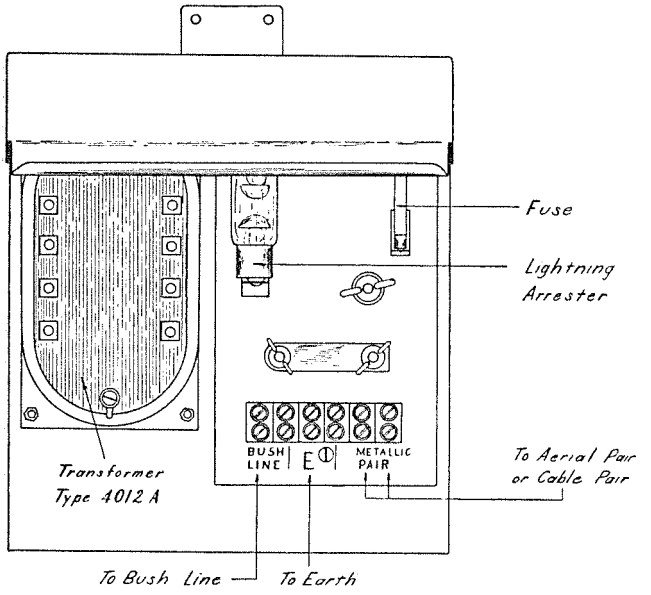


Fig. 26.



Line Transformer with Lightning Protection

Fig. 27.

INSTALLATION OF TEMPORARY LINES.

Required during fire season and development work.

81. Temporary telephone communication is often required during the fire season or when developmental work is in progress. In these cases the cost of erecting the normal bush telephone line is out of proportion to its period of use and a simpler construction is used.

Wire type.

82. The G.I. wire line is replaced by a flexible 7 strand tin plated steel wire covered with a cotton braid. A few miles of cable and a reel should always be on hand at the Divisional Headquarters.

Laying the cable.

83. The "start end" of the cable should be brought out clear of the drum before winding the cable on the drum, so that connections can be made to the partly unwound coil.

The cable is laid on the road fringe where vehicles cannot damage it. At crossings it will be necessary to elevate the cable with temporary ties to trees. The line should be laid in such a way that picking it up at a later date can be done with ease.

To prevent deterioration of the insulation temporary cables should not be left lying in the bush longer than necessary.

Joining a temporary cable.

84. Temporary cables are joined baring the ends of the cable and twisting the bare ends together. To avoid unravelling of the strands, the bare end should be knotted prior to twisting together.

Connecting the phone to the cable.

85. Two lengths of cable about 30ft. long should be carried and each end of these cables should be terminated by a 25 amp. battery alligator clip. Covered auto cable 3 m.m. PVC is suitable for the short cable lengths.

These are then used to connect the field cable line to the phone terminal. The telephone for this work should be the **Ericsson portable type N1845V.**

The earth connection may be made by driving a spike into moist earth or into the butt of a marri tree. A galvanised steel star fence post makes a good temporary earth electrode.

TELEPHONE INSTRUMENTS AND ACCESSORIES.

Types of telephones in use.

86. Telephone types used are Ericsson models—

Table—N2124.

Wall—N2206.

Portable—N1845.

These telephones give a much higher performance than the older types they replace.

Telephone theory.

87. A brief description of the principal components of the telephone follows to enable field staff to gain a working knowledge of the instrument and accessories. Usually spare instruments are readily available to enable an easy exchange of faulty ones, but occasionally simple faults can be remedied on the spot by reference to the following paragraphs.

Magnetos.

88. A hand operated alternating current generator is set in each phone for the purpose of signalling other telephones, i.e., bell ringing. At normal turning speeds it supplies A.C. current at approximately 17½ cycles per second. The output voltage and current are—

No load 100 volts — amps.

Full load 30 volts .06 amps.

When the ringing crank handle is turned it operates a switch which conducts the magneto across the line and removes a bridging wire across the magneto. On turning the handle (a) makes contact, (b) breaks contact. See Fig. 28.

Switch contacts occasionally become dirty and bent out of adjustment, but these faults are easily remedied. Line conditions can be judged with reasonable accuracy from the effort required to turn the crank. Stiffness indicates a heavily loaded or short circuited line, while easy turning indicates a light load or open circulated line.

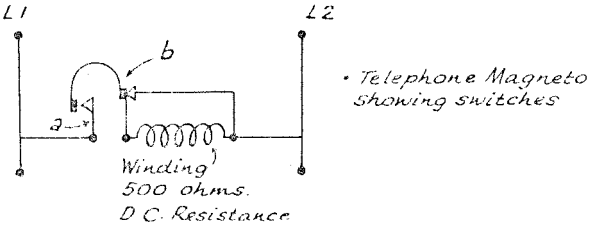


Fig. 28.

Micro-telephone or hand piece.

89. The telephone hand piece houses the receiver and microphone. A simplified diagram showing the functions of these two components illustrates the speech circuit. See Fig. 29.

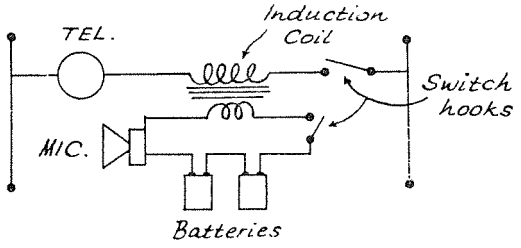


Fig. 29.

Microphone.

90. The microphone consists of a compartment loosely packed with carbon granules. The voice impinges on a diaphragm which transmits voice vibrations to the granules, so that the battery current flowing through them varies with the voice modulation. The induction coil passes these speech frequencies to the line.

The receiver.

91. The receiver consists of a permanent magnet on which is wound a spool of very fine wire. Speech impulses pass through this wire and tend to add to and cancel alternatively the magnet's power. Situated very close to the pulse of the magnet is an iron diaphragm which reacts to the magnetic pull. It converts these magnetic speech currents to audible sound by exciting the air surrounding the diaphragm.

The induction coil or transformer.

92. The induction coil or transformer magnetically couples the microphone circuit to the lines via the receiver, so that D.C. battery current does not flow in the line. As seen in Fig. 29, it has two separate windings. The turns ratio is approximately 1:10 so that D.C. voltage fluctuations in the primary (microphone) circuit are magnified 10 times (ignoring losses), in the line circuit and conversely the current decreases 10 times in the line circuit. As long telephone lines naturally have a high resistance, owing to the economic restrictions on the line diameter, a higher voltage with lower current suffers least loss since—

Line losses = Current squared × Resistance.

Line losses are thus reduced in effect 100 times with a 1:10 ratio transformer. From the foregoing it would appear that the greater the turns ratio, the greater the gain, but the other line losses, such as insulation resistance, effectively limits the ratio to an optimum value. Spot corrosion and lightning can cause open circuit or shorts between windings; however, these coils generaly give very little trouble.

Batteries.

93. Each telephone uses two 1.5 volt dry cells to energise the local microphone circuit. These should be replaced after two years, or as soon as the voltage per cell falls to 1.2 or under. Cells used at a lower voltage than this can fail quite suddenly and also cause distortion to speech. A simple, cheap, but accurate pocket voltmeter should be available at District offices for this purpose. Cells can give rise to intermittent open circuits and induce noise through construction faults and should be tested by tapping the terminal posts with a pair of pliers while listening to the receiver.

The switch hook.

94. On removing the hand piece the switch hook moves upwards, actuating the switch which brings the speech section of the telephone into circuit. This connects the battery to the microphone and connects the induction coil and receiver across the line. Cleanliness and adjustment of this switch will eliminate many common faults in telephones.

Bells.

95. The telephone bell is operated by an alternating current from the magneto and the armature is polarised by a built-in permanent magnet. By this method the armature is held firmly against one pole so that small line induced voltages will not tinkle the bell. Little can be done in the field to repair bells, so it is best to replace faulty ones. Bells are rewound by Radio Branch, so that the D.C. resistance lies between 2000-2500 ohms.

Telephone protection.

96. To protect the telephone instruments against damage from lightning and accidental contact with power lines, safety devices are connected in the circuit, as follows—

(i) The line is broken and cartridge fuses are inserted in series with it. These fuses are rated at 1.5 amps and will burn out if currents exceeding this value enter the line.

(ii) Gaseous lightning arresters are connected from the line to earth. These arresters are small glass cartridges with contacts at each end and filled with Argon or Neon gas. See Fig. 30.

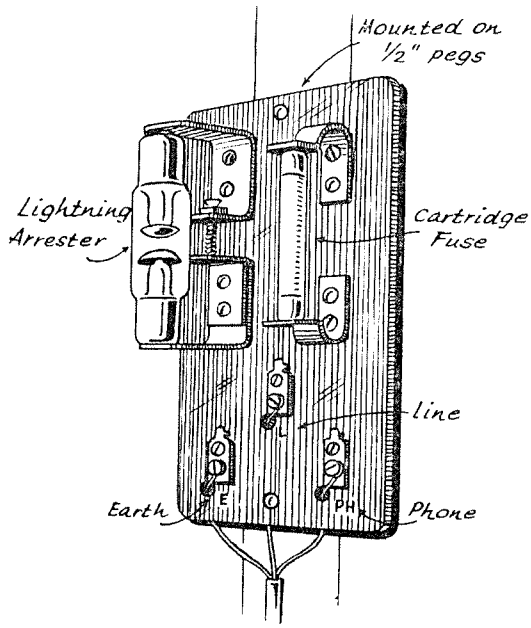


Fig. 30.

When induced line voltages exceed approximately 300 volts, the gas is ionised, meaning in simple terms that it becomes a conductor, so that its load as presented to the line falls from many million ohms to a few hundred. This comparatively low resistance supplies a path across which the line can discharge itself. As soon as the line is completely discharged, the gas automatically assumes its normal state of extremely high resistance.

The virtue of this device as against the old carbon block is that it is self healing and requires no inspection or maintenance, so that after lightning storms, the telephone system is completely serviceable. It is important that all lines have adequate protection with gaseous arresters. Full protection against severe and direct lightning strikes is almost impossible unless the lines are grounded outside the building during these storms.

SWITCHBOARDS.

97. These boards are made to order by requisition on Radio Branch. Sizes are 2, 4, 6 and 8 line. Each board is self-contained and when supplied requires only fixing to the wall with four small screws and fitting of connection wires to marked connector blocks. Switchboard supply.

98. A coloured marking system is used throughout the board and corresponds to the colour marking of lines, e.g. in an 8 line board the lines are colour marked from the left—red, blue, white, yellow, brown, green, grey and black. In addition each fuse, arrester, and switch is colour marked according to the line it is connected with. Switchboard facilities.

(i) To answer a call, place the switch in the "down" position and answer the "caller." Switchboard operation.

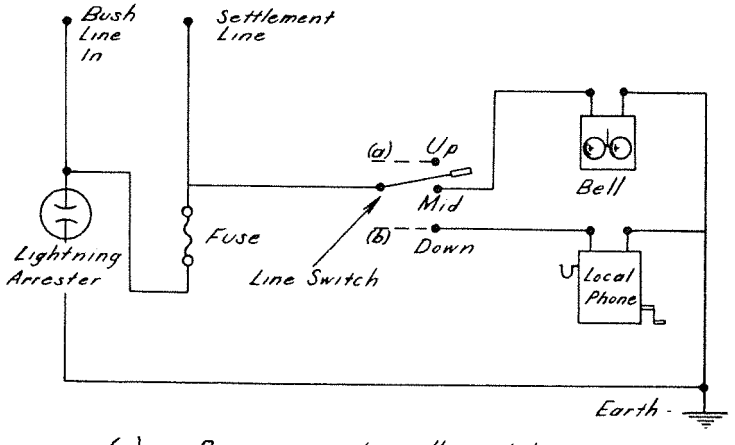
(ii) To ring out, first return the switch to the centre position, move the "out call" switch to the down position and code ring the party required.

(iii) When this party answers, move the "in call" line switch to the down position, tell the parties to "go ahead" and smartly move the two switches concerned to the "up" position.

This action disconnects the switchboard telephone from the two lines.

Another incoming call can now be answered without interferring with the two parties already in conversation, by moving the line switch to the "down" position.

99. The fundamental wiring circuit is shown in Fig. 31. Circuit wiring.



(a) Bar connects all switches.
(b) Bar connects all switches to phone.

Fig. 31.

The circuit in Fig. 31 is for one line only, but is repeated for any number of lines, excluding a 2 line board where for economy, one switch performs all functions.

Metallic return circuit switchboards.

100. The switchboards used in metallic return circuits installed in the larger settlements differ slightly from the standard. An answering key is added on the right hand end of each switch row. With this faciilty, it is possible to monitor calls in the "up" and "down" key positions.

Switchboards for lookout towers.

101. A removeable switchboard has been developed for towers—See Fig. 32. Its principal feature is easy removal.

It is essential that tower switchboards are stored during the winter in a lined storeroom to protect them against moisture and corrosion. V.H.F. radio huts are very suitable for storing these switchboards.

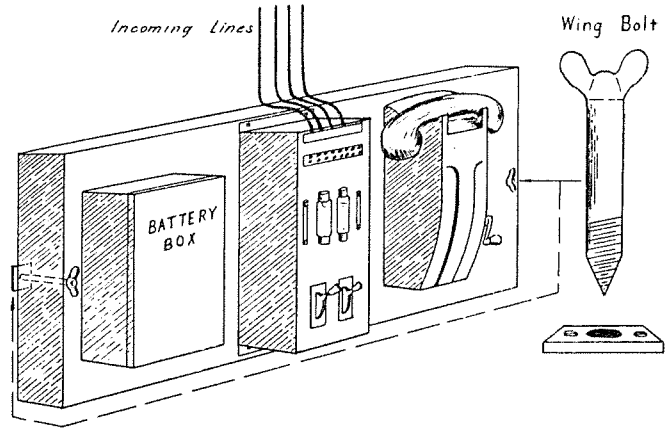


Fig. 32. Fig. 32 (a).

INSTRUCTIONS FOR INSTALLING SWITCHBOARDS FOR BUSH TELEPHONE LINES

Particulars to be supplied when ordering switchboards.

102. Switchboards are custom built at Radio Branch to suit each particular installation, and when ordering by requisition or memorandum, the following particulars should be supplied:—

(1) A simple sketch of the installation.
(2) The measurements of cables.
(3) Any special switching requirements.

Limitation on load.

103. To preserve the efficiency of bush telephone lines, limitations on line load are made under:—

(1) For large Divisional settlements — 1 office switchboard and up to 3 settlement switchboards.
(2) For District settlements — 1 office switchboard and up to 2 settlement switchboards.

A typical installation.

104. Fig. 33 shows the typical installation for an office.

Bush telephone lines are brought into the office switchboard directly and no branches are made from it.

Lines in settlement.

Settlement lines are run out from the office switchboard to feed other switchboards on the settlement.

The settlement house line (red) is run out with the settlement lines.

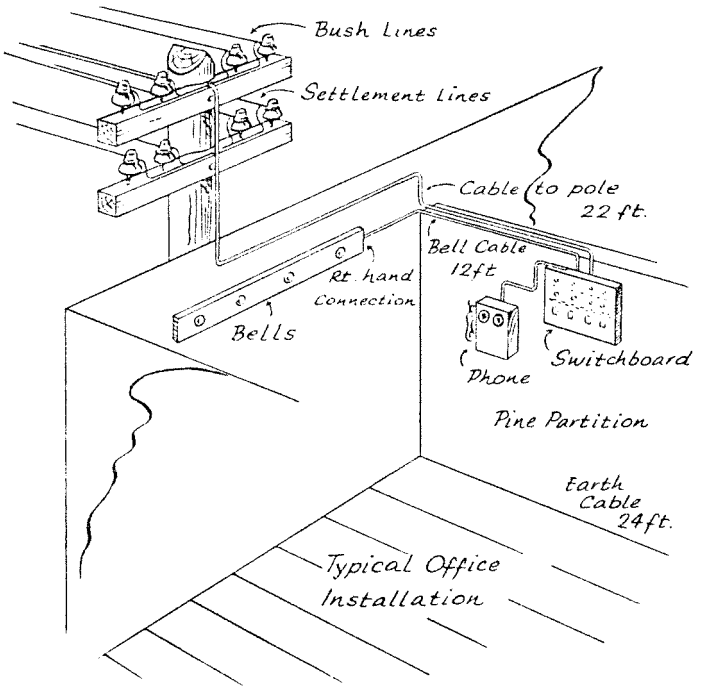


Fig. 33.

Installing a switchboard.

105. The cables should be laid out on temporary fastenings to check length. The bell board, telephone and switchboard are then fixed in the desired positions. The cable is then permanently installed with the fixing clamps provided and the ends of the cables bared for about ½ in. and inserted into their correct connections.

Identification system.

106. All cables to the switchboard are coloured for easy identification:—

	Line Colour	Service
1	Red	Settlement house line
2	Blue	Bush line.
3	White	,, ,,
4	Yellow	,, ,,
5	Brown	,, ,,
6	Green	,, ,,
7	Grey	,, ,,
8	Black	,, ,,

Cables, fuses, arresters and terminals are in the colour of the line they represent. Each wire entering a switchboard is provided with a guide hole and a screw clamp, and each screw clamp is coloured and labelled. It is an advantage to extend the colouring system to cross arms outside the office and to the bush line dead ends to assist in fault finding.

Testing.

107. Fig. 34 illustrates a typical installation and testing should be carried out as follows:—

Remove the fuse and place the test lead in contact with the upper fuse contact carying two wires (A1 in Fig. 34). With the switches in the centre position turn the magneto handle and the local bell and other bells on the line in the settlement

will ring. Talk over this line to the settlement switchboards and ask them to ring back. The complete settlement has been tested for one line. This should be repeated on the remaining lines. To test bush lines, transfer the test lead to the other (lower) end of the fuse (A in Fig. 34), ring out and talk over each bush line. If more effort than usual is required to turn the handle, a short circuit is indicated and if less effort than usual is required, an open circuit is indicated.

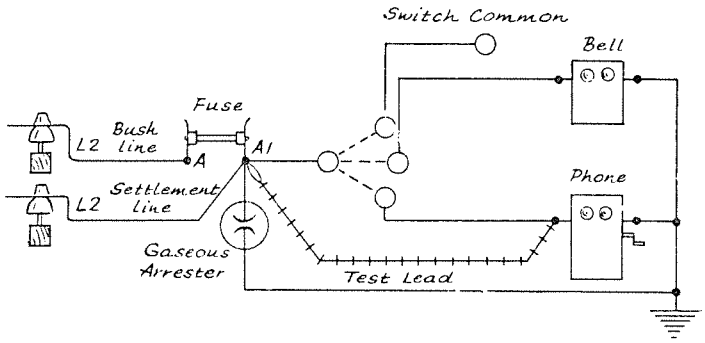


Fig. 34.

Earthing.

(See also para. 113.)

108. The necessity for a good earth system cannot be over-emphasised. A short direct earth is necessary for the lightning arresters but the telephone earth may have to be of considerable length (even miles) to be effective. Where a long earth is indicated, the line should be run through the bush in a similar manner to a telephone line and supported **by insulators.**

Alternating current —hum indication.

109. When alternating current power cables are present in a settlement, technical assistance should be sought before earthing system is installed. Hum induction is introduced via the earth connection and through faulty insulation. The cure usually is to run a 14 s.w.g. copper aerial earth around the settlement on insulators for earthing purposes and an insulated line run into the bush and buried in moist mineral earth free from A.C. currents.

Gaseous line protectors will require a separate short direct earth close to each switchboard.

110. Near each switchboard, a placard should be placed showing the parties connected to each line and the code ring allotted to them. Coding should be simply arranged so that officers from other districts acting as reinforcements during major fires will find the switchboards simple to operate.

Officers to seek advice from Telecommunications Officer.

111. Forest staff officers responsible for telephone communications within their Division may at all times ask the Telecommunications Officer to advise, inspect and lay out telephone systems.

Line testing from main switchboard.

112. Without any special apparatus, telephone lines and accessories can be tested by using the local telephone and the main switchboard, as follows:—

(i) Firstly, remove all line fuses and connect a short length of wire into the terminal marked "local phone," with all switches in the "mid" position.

(ii) Test extension bells by pressing the bared end of the wire in turn into terminals marked "Bell 1," "Bell 2," and so on. Each extension bell in the office will ring in turn as the magneto is cranked.

(iii) Next press the wire into each outgoing line and call a station at the end of the line.

(iv) Finally press the wire into each settlement line terminal and call a house on the settlement.

When locating faults, the breaking of an installation into sections and testing by elimination is preferable to other methods. On all switchboards the bottom terminal of the fuse is the bush line and the top terminal is the settlement line. These posts can be used for testing instead of the connector.

TELEPHONE EARTHS.

113. A low resistance earth connection is essential for maximum efficiency in single wire lines and for reducing cross talk to a minimum. **Many line troubles are traced to an inefficient earth connection.**

Earths for lightning protection.

114. For the purposes of lightning protection, a short direct earth is required and a reasonable amount of earth resistance contact can be tolerated. To effectively earth the telephone circuits, the lowest possible resistance is desired and should the short direct lightning earth not provide this low resistance, a remote earth must be resorted to. This remote earth may even be as much as half-a-mile away and should be located in heavy mineral soil which retains its dampness throughout the summer. The line connecting a remote earth to the settlement switchboards should be erected and insulated in a similar manner to the bush telephone line. Using water pipe systems for earthing can give trouble as jointing compounds can cause low conductivity. As pipe systems are also used for electrical earths, hum trouble may result.

The importance of a good earth.

115. The earth connection is so important that it is worthwhile experimenting with various sites. A post hole digging tool capable of digging to 15ft. can be used for the purpose. If laterite rock is encountered it can be taken as an unsatisfactory earth site.

The best telephone earth.

116. The most effective method is to bore a hole into a suitable earth site with a post hole digger between 4" and 6" diameter. The hole should be as deep as possible (say 10ft. to 20ft.). A soft copper plate rolled into a helix is thrust to the bottom of the hole with a 7/044 copper connecting cable welded to the earth plate. It is an advantage if the connecting cable is PVC (plastic) insulated to prevent corrosion and to avoid to some extent the introduction of A.C. earth surface currents. See Fig. 35.

When filling in earth plate excavations, it is important that a high conductivity mineral be added to the soil. Copper sulphate is ideal for the purpose and when added to crushed charcoal, greatly reduces the earth resistance.

It is important that earth locations be kept damp.

Replaced earth must be rammed tight to increase contact pressure between the earth plate and filling.

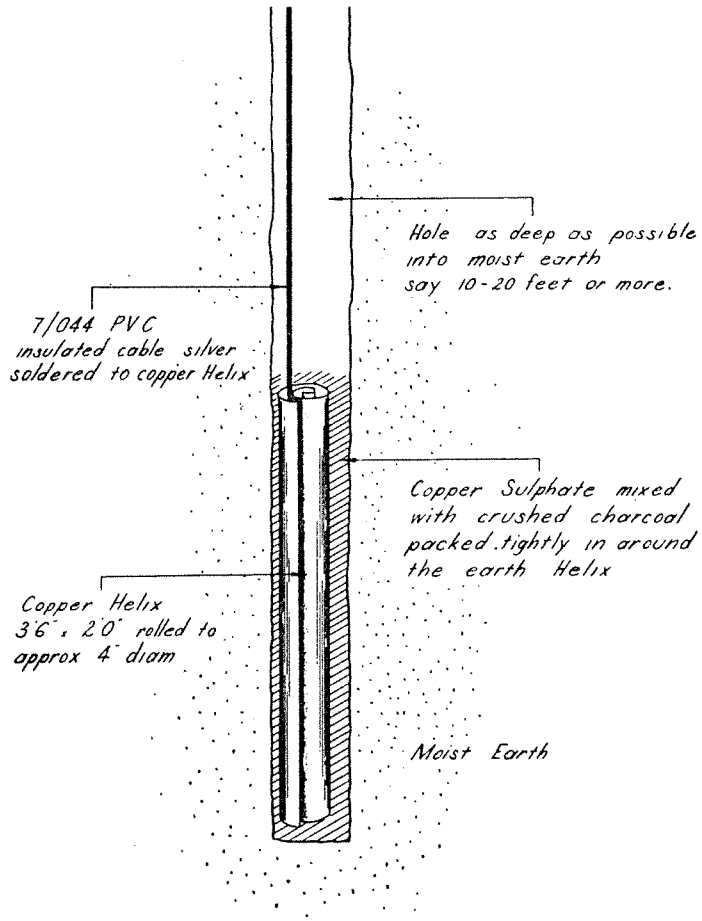


Fig. 35.

The undesirable results of poor earthing.

117. Fig. 36 shows Station A ringing Station C. Stations A and B are connected with 10 miles of line to Station C and the following cases illustrate the undesirable results of faulty earthing.

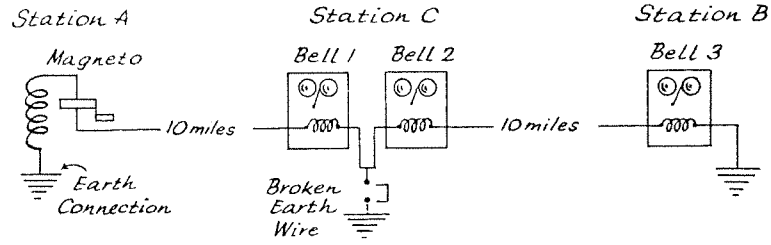


Fig. 36.

(1) **A Broken Earth.**—The magneto at A sends the line current to Station C through Bell 1 to the earth connection. This connection is broken so the current can only reach earth via Bell 2 through Bell 3 so that all bells ring with equal force. If the earth is effective the ringing current after passing through Bell 1 would enter the earth and no current would be available to pass through Bells 2 and 3.

(2) **An Inefficient Earth.**—If the earth point has a resistance, some of the current will pass through the earth connection and the remainder will pass through Bells 2 and 3 (which will tinkle) to earth and then back to Station A. The same would apply to voice currents giving rise to unwanted phenomenon called "cross talk."

Telephone earths not to be sited near electrical earths.

118. Telephone earths sited near electrical earths can be responsible for the introduction of alternating current 50 cycle hum. Physical removal of the telephone earth to good conducting soil at a distance from the electrical earth will generally be effective. A short direct earth is still required for connection to the lightning arrester but the telephone and arrester earth must not make contact.

INDOOR INSTALLATION TROUBLES.

Testing telephones.

119. Field Staff can make certain simple tests of office and house telephone installations.

120. It is best to test telephone instruments by substitution. A good portable telephone known to be in good condition can be connected across each line in turn and tests made by ringing out and answering. Telephones should be replaced where low performance is indicated.

Testing switchboards.

121. Key lever switches may suffer burnt contact points through lightning strikes and cause noise and line breaks. To test, connect the portable telephone across the faulty line and earth, with the switch off.

Loose fuseholders.

122. Fuses on switchboards may cause intermittent contact or even open circuit. The mounting arms may require bending to give better contact pressure.

123. The cable connectors clamping screws on the top of the switchboard may occasionally require checking for tightness.

Earth connections.

124. Earth connections need an occasional check to see that they are tight and free from corrosion. It is emphasised that the earth installation of switchboards is not permanent and at periods requires reconditioning by renewing the cable and replacing badly corroded earth plates. If bells other than the one being signalled tremble, it indicates a faulty and inefficient earth connection.

125. In cases where switchboards have been badly marked by lightning flashovers, replacement of the whole switchboard is advisable.

126. Switchboards should be given an occasional clean with a brush as clean parts will give better service. If switches

become stiff or occasionally squeak when moved, push the switch up and let three drops of typewriter or sewing machine oil run over the cam. (See Fig. 37.)

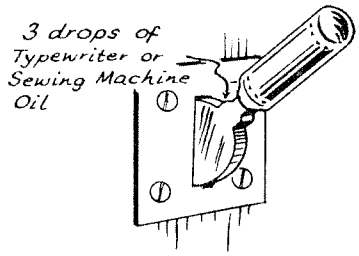


Fig. 37.

APPENDIX "A"

LIST OF STANDARD TELEPHONE MATERIAL

127. The following is a list of standard telephone material:—

Item No.	Item	Description
1	Insulator, Porcelain, Solid Reel	New line construction. Measures 2 in. high, 2½ in. diameter, ¾ in. hole. See Fig 38.
2	Insulator, Porcelain, Split Reel	For replacements of broken line insulators. See Fig. 38.
3	Insulator, Porcelain, Skirted small	3 in. maximum diameter skirt, 3 in. high, body threaded 8 turns per inch, 1 in. diameter. See Fig. 38.
4	Insulator, Porcelain, Skirted large	3½ in. maximum diameter skirt, 4 in. high, body threaded as for Item 3 above. See Fig. 3.
5	Insulator, Porcelain, Guy Strain (Egg insulator)	1⅝ in. diameter, 3 in. long. For telephone dead ends and radio aerials. See Fig 38.
6	Spindle, Galvanised Steel Swan Neck	½ in. diameter for normal loads, ⅝ in. diameter for heavy loads. For use with insulators Items 3 and 4. See Fig. 38.
6a	Spindle, galvanised steel "J" bolt	For use with insulators on terminating poles. See Fig. 38.
7	Spindle, Galvanised Steel Straight	½ in. diameter for normal loads, ⅝ in. diameter for heavy loads. For insulator heads Items 3 and 4 for use with 3 in. crossarms. See Fig. 38.

Item No.	Item	Description
8	Spindle, Wooden	Wandoo with $\frac{7}{8}$ in. shank for use with Item 3. For use with 3 in. x 3 in. crossarms. See Fig. 38.
9	Pins, Wooden	Wandoo with $\frac{7}{8}$ in. shank. For hanging tree lines with Items 1 and 2. Used in growing timber. See Fig. 38.
10	Pins, Steel	For hanging tree lines with Items 1 and 2. Used in poles. Made from mild steel $\frac{1}{2}$ in. square. See Fig. 38.
11	Wire, Telephone, No. s.w.g., G.I.	Galvanised mild steel wire. Semi soft, equivalent to P.M.G. 400 lb. per mile. For tree lines in forest. See Fig. 39.
12	Wire, Telephone, No. 14 s.w.g., Copper	Hard drawn pure copper, equivalent to P.M.G. 100 lb. per mile. For pole lines, crossings, etc. See Fig. 39.
13	Wire, Tie, G.I., Soft	12 s.w.g. galvanised soft iron. For insulator ties. See Fig. 39.
14	Wire, Tie, 14 s.w.g., Copper	This is Item No. 12—Fire softened. Used for typing lines to insulators, Items 3 and 4. See Fig. 39.
15	Sleeves, Jointing, No. 3	Used for jointing No. 14 s.w.g. copper wires. See Fig. 39.
16	Sleeves, Jointing, No. 11 (b)	Used for jointing No. 8 s.w.g. G.I. wires. See Fig. 39.
17	Sleeves, Adaptor	Used for jointing No. 14 s.w.g. copper to No. 8 s.w.g. G.I. See Fig. 39.
18	Sleeves, Tee	Used for tee jointing a No. 14 s.w.g. copper line to a No. 8 s.w.g. G.I. line without breaking it. See Fig. 39.
19	Tools, Jointing	A compression type compression jointing tool. Joins No. 8 and No. 3 21 in. long. See Fig. 1.
20	Tools, Line Strainer	Buffalo wire grip—See Fig. 19a. For gripping and pulling up No. 14 s.w.g. copper wire.
21	Wire, Telephone, Insulated	7-strand fabric insulated, 1 strand copper, 6 strands tinned steel. For temporary bush lines. Standard drum contains 1 mile.
22	Cable, P.V.C. 1/064	For indoor installations of bush telephone lines. Colours are red, blue, white, green, brown, yellow and black.
23	Apparatus, Cable-laying	Winding machine for laying and picking up Item 21.
24	Telephone, Portable	Standard model Erissson N1845K 2000 ohm with 3 watt magneto. See Fig. 40.
25	Telephone, Table, N2124 B8T, Long Cord ; N2124 B7T, Short Cord	The newly introduced standard table telephone. See Fig. 40.
26	Telephone, Wall Telephone, N2206B7T, Long Cord ; N2206B6T, Short Cord	The new replacement standard wall telephone. See Fig. 40.
27	Cells, Dry, 1·5, Eveready No. 6, $6\frac{1}{2}$ in. high x $2\frac{1}{2}$ in. diameter	Wall and table telephones, Items 25 and 26.
28	Cells, Dry, 1·5, Eveready x 71	For portable telephones, Item 24.

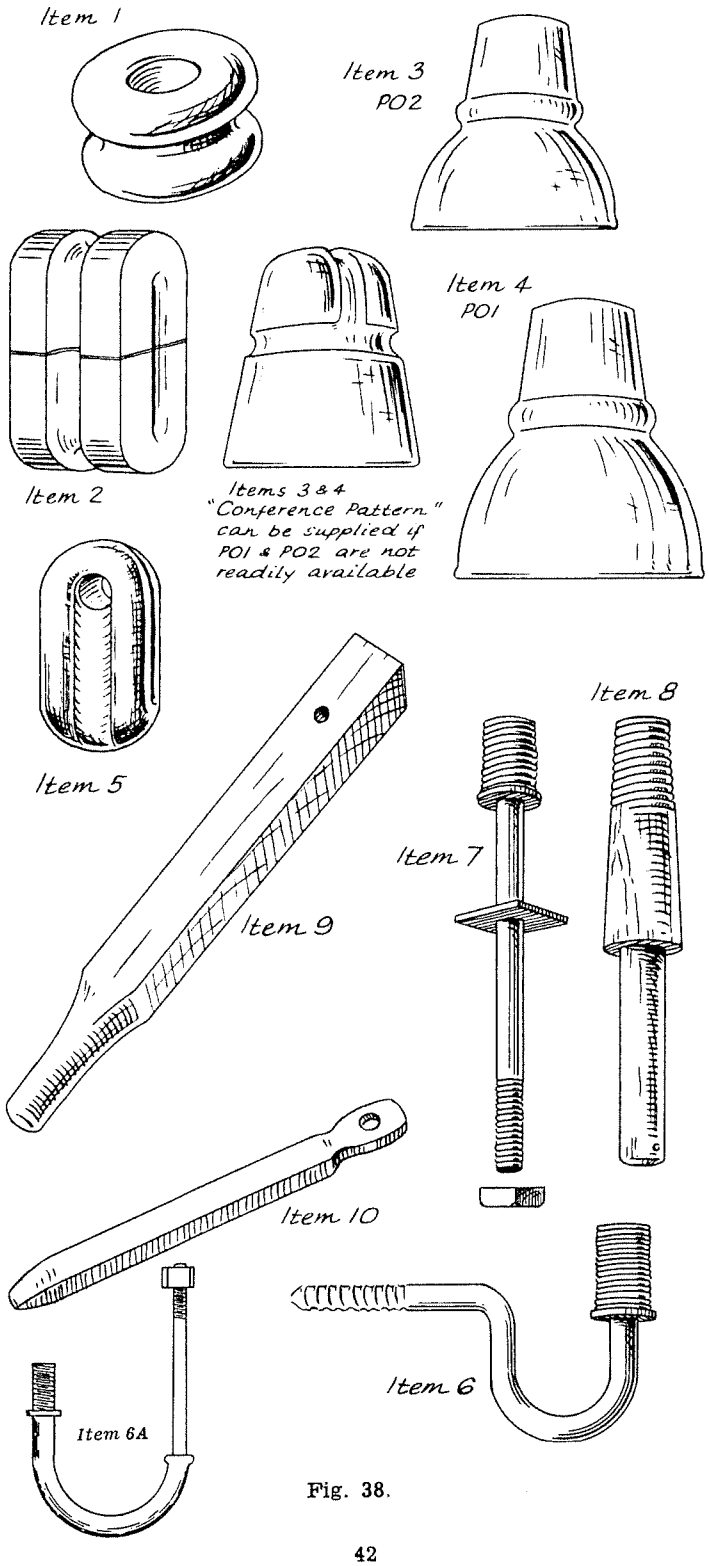

Item 1
Item 3
PO2
Item 4
PO1
Item 2
Items 3 & 4
"Conference Pattern"
can be supplied if
PO1 & PO2 are not
readily available
Item 5
Item 8
Item 7
Item 9
Item 10
Item 6A
Item 6

Fig. 38.

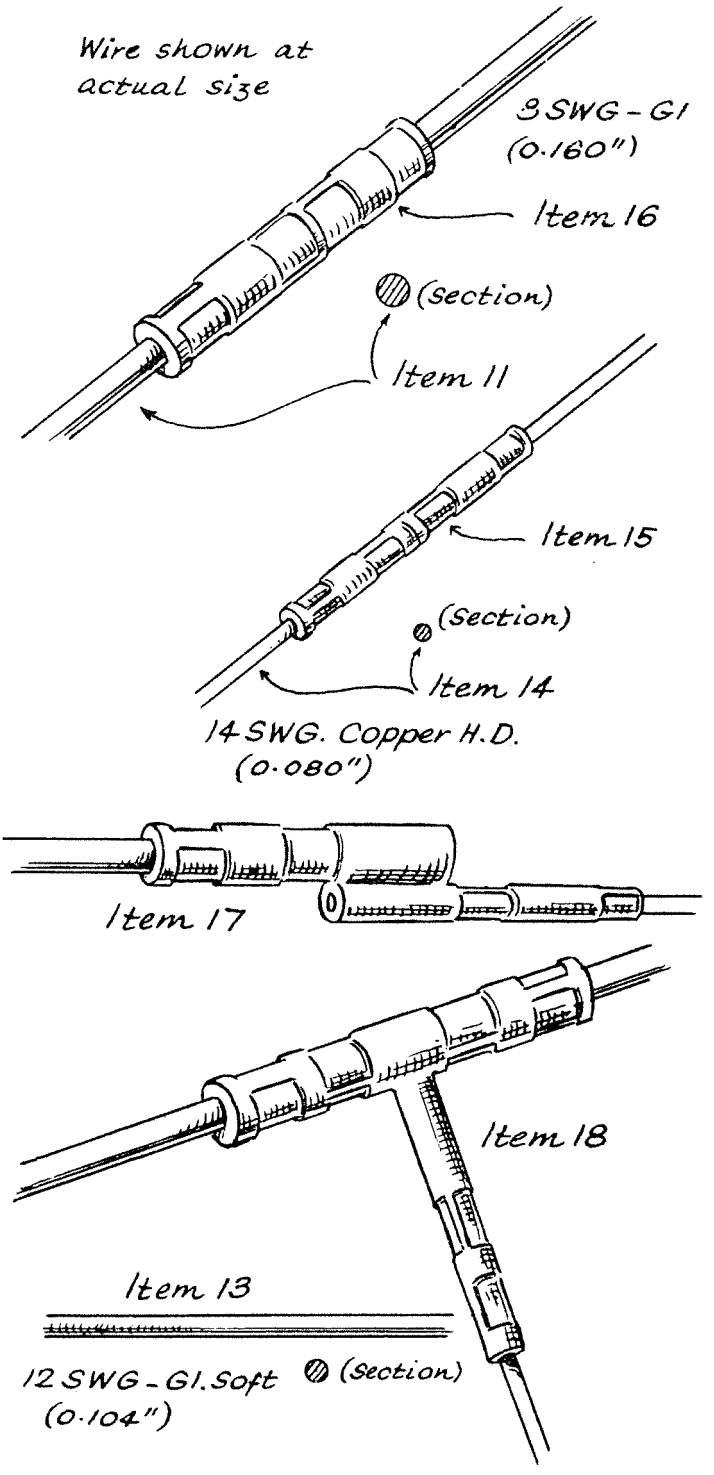

Wire shown at actual size
3 SWG - G1 (0.160")
Item 16
(Section)
Item 11
Item 15
(Section)
Item 14
14 SWG. Copper H.D. (0.080")
Item 17
Item 18
Item 13
12 SWG - G1. Soft
(Section)
(0.104")

Fig. 39.

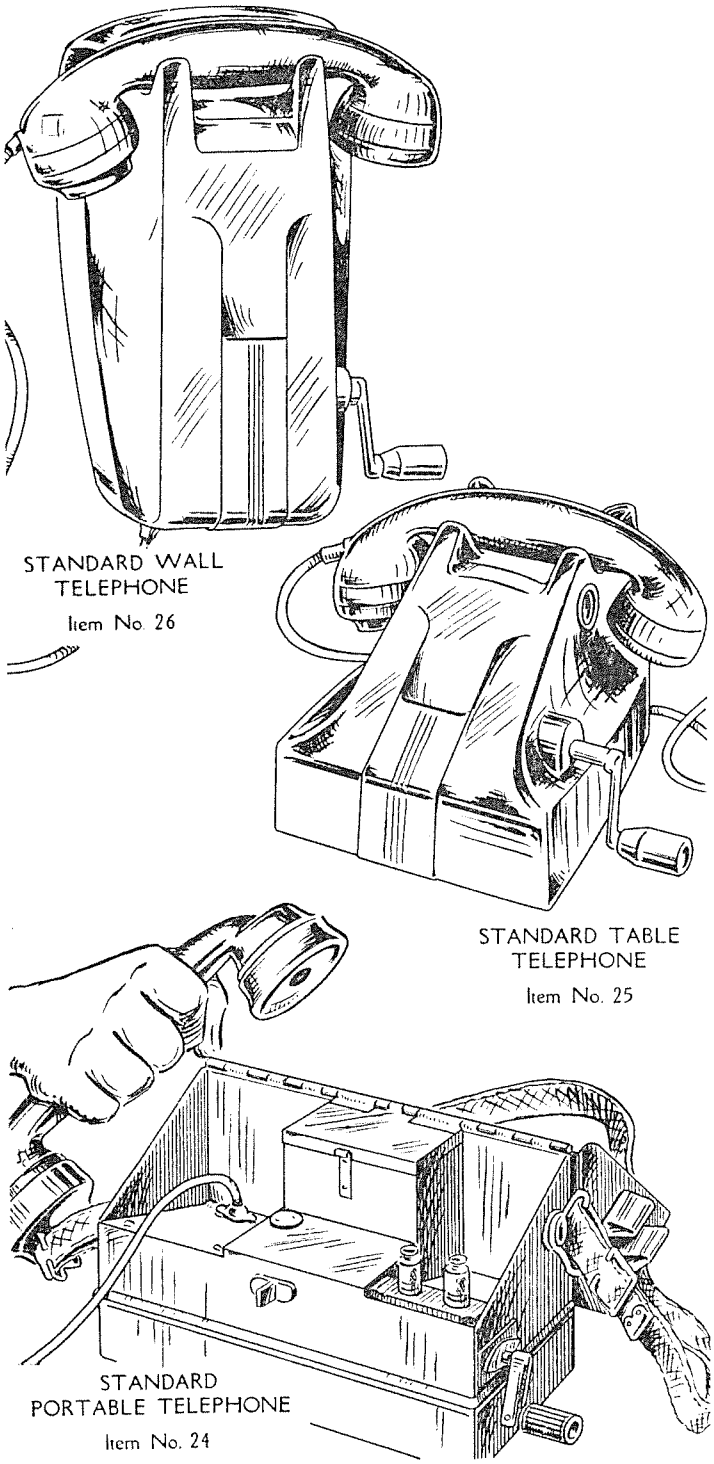

STANDARD WALL
TELEPHONE
Item No. 26
STANDARD TABLE
TELEPHONE
Item No. 25
STANDARD
PORTABLE TELEPHONE
Item No. 24

Fig. 40.

APPENDIX "B"

GENERAL DESCRIPTION OF NEW TELEPHONE TYPES

128. All of the telephones in use, although in good order are very old and it is planned to gradually replace them with modern types incorporating all the advances in design achieved for the magneto telephone.

129. The two types of telephone being introduced for this purpose are made by Ericsson Telephones Limited.

(1) Table Telephone Magneto.
Type (a) N2124 B7T short cord.
(b) N2124 B8T long cord.

(2) Wall Telephone.
Type (a) N2206 B6T short cord.
(b) N2206 B7T long cord.

130. The instruments are housed in polished one piece black mouldings of modern form with a ribbed front. Plastic insulated wire and cord, and varnish impregnated coils ensure satisfactory service under all conditions.

A curved handset of pleasing design is far more sensitive than our previous types and this factor will help considerably on long heavily loaded Departmental lines.

131. The chief advantages of this new instrument is that it is equipped with a heavy duty ringing magneto with an output of 4.5 watts measured into its optimum load. **Additional ringing power.**

This is an increase of 60 per cent over our previous telephones and this extra ringing power is very acceptable.

132. Lubrication is adequate for many years under normal conditions of service. A few drops of colloidal graphite in fine oil every 5 years is adequate. **Lubrication.**

133. The following are instructions to be followed when connecting the new wall types:— **Connections. Wall type.**

Line—
L1 to terminal 1.
L2 earth to terminal 9.
Battery to terminals 1 and 8 (any polarity).
Handset—
Green wire to terminal 6.
Red wire to terminal 5.
White wire to terminal 4.

The table handsets are provided with a flexible connecting cord and terminal box. **Table Type.**

Connections in the boxes are:—
L1—Red.
L2—White.
Battery—Green and Blue.
Red and Green are bridged.

134. An advantage with this type of telephone is that the batteries remain with the installation when the telephone is removed, thus considerably reducing the volume of the telephone for packing. **Separate battery box.**

A battery box is supplied with each telephone for wall mounting. Connection is made to the telephone with two wires to terminals 1 and 8 (or red and blue for table models).

135. The bush telephone network will gain considerable benefit from fitting these new telephones, but because of this improvement, there will be a tendency to load existing lines with additional length and instruments, which will nullify their advantages.

Officers responsible for the telephone network should discourage this tendency so that the gain in efficiency will remain a permanent one.