BULLETIN 58
PAMPHLET No. 8
1972

FORESTERS' MANUAL

COMMUNICATIONS
TELEPHONE

FORESTS DEPARTMENT
PERTH
WESTERN AUSTRALIA

CONTENTS

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 the main changes occurring in the bush telephone system are:

(a) All telephone cables within most settlements have been placed underground. These settlements are Wanneroo, Gnangara, Mundaring, Dwellingup, Harvey, Collie, Kirup, Grimwade, Nannup, Ludlow, Manjimup, Pemberton and Walpole.

(b) Distribution of P.M.G. services in a settlement is *via* F.D. underground cables. This results in a considerable annual saving, otherwise payable to the P.M.G. in line rental.

(c) The pending development of extended local control of radio telephone to enable after hours contact with smoke-reporting towers.

(4) The most notable development in recent years has been the successful introduction of radio telephones to replace long, aged bush telephone lines. This development is likely to continue, as replacement costs of bush lines have risen sharply in recent years. Each year bush line maintenance costs continue to rise and this is another factor in favour of radio telephone.

(5) 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.

(6) 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.

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

(8) Head Office consent is required for the installation, removal or cessation of maintenance of bush telephone lines.

INTRODUCTION AND PLANNING

General

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 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 soft 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
No. 8	Med - soft iron wire galvanised	lb. 400	lb. 1100–1250	ohms 15	$45 per mile $250 per ton
No. 14	Hard drawn copper	100	330	8.7	$80 per mile $1,700 per ton

Prices are approximately those ruling in June, 1971.

Equipment.

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

1 light motor truck.
2 tents and 3 flies. (If camping out.)
1 only 14 ft. ladder (light in weight) and 1 only 16 ft. (or 17 ft.) ladder.
N.B.—The higher ladder is required for boring holes for wooden pins.
1 wire jenny.
3 axes.
1 10 in. 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 in. double side cutting).
1 pair linesman's pliers (8 in.).
1 wire key (for No. 8 wire).
1 safety belt (with a leather strap extension).
1 brace and the following bits: 5/16 in., 7/16 in., $\frac{1}{2}$ in., $\frac{5}{8}$ in. and $\frac{7}{8}$ in., 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 in. rope 30 feet long.
1 Testmeter.

Jointing the line.

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 sleves, 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 per cent. and a mechanical union strength of 95 per cent.

Sleeve types.

18. The sleeves types used are as follows:—

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

(ii) For jointing No. 8 s.w.g. galvanised iron wire—
Sleeve No. 11 (b).
Gloove size 5/16 in.
Wire diameter 0.160 in.

(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.

Making a joint.

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

(i) Lightly scrape the wire with the *back* edge of a knife to clean it —do not remove galvanising.

(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, making each squeeze at 180° rotation.

Care of the jointing tool.

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.

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.

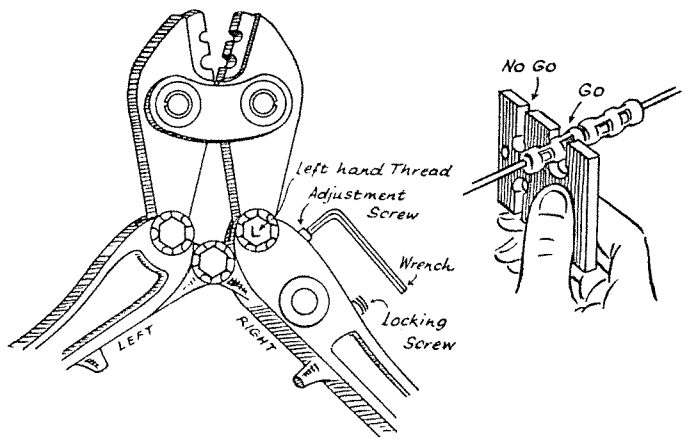


Fig. 1.

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 17 feet 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 ringbarked 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 30 feet 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 install a temporary line and test the amount of hum induction first.

(vi) Rocky stretches and bad swamps shoud 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.)

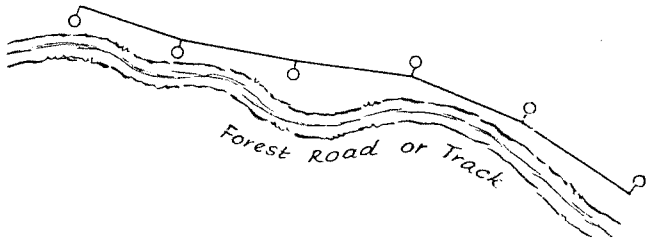


Fig. 2.

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 inches diameter at 17 feet. 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 feet to 8 feet is ideal, but may vary from *nil* up to 15 feet in 40-yard spans, or *nil* up to 18 feet 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 15 feet or 18 feet given in the preceding paragraph. (See Fig. 3a.)

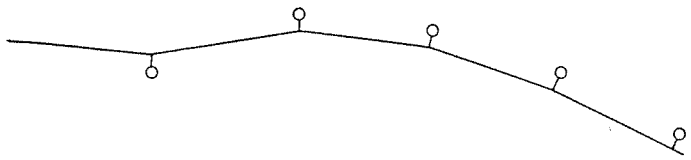


Fig. 3a.

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.)

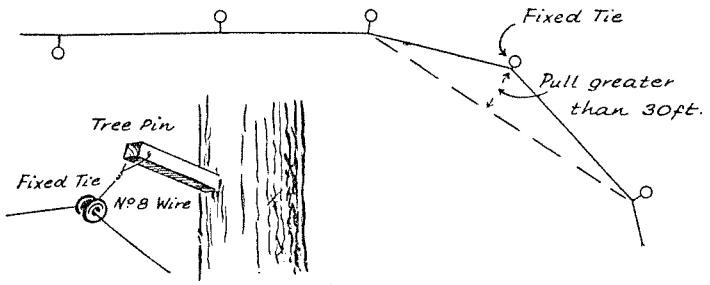


Fig. 3b.

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

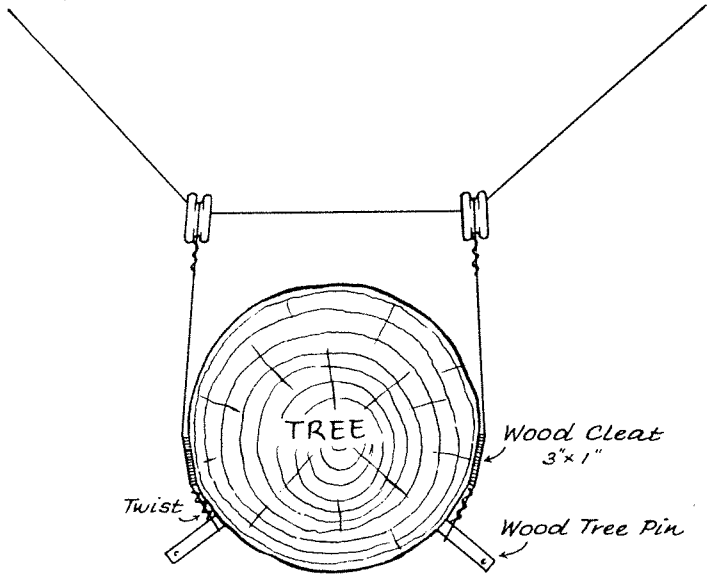


Fig. 4.

31. Two systems of alignment may be followed— Alignment systems.

(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).

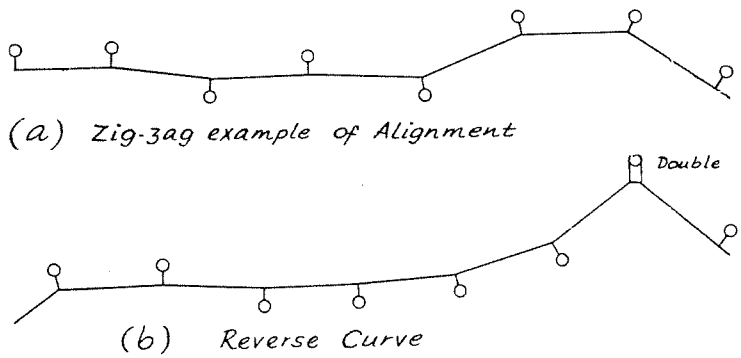


Fig. 5.

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.

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. Use of poles in poorly stocked forest.

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 feet 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 feet and stands out some 8 inches from the blazed side of the tree.

Minimum felling.

36. A dense coppice growth from stumps quickly grows up to the line, it is preferable to prune branches from trees, rather than fell 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 17 feet above the ground with a brace and $\frac{7}{8}$ in. bit for the pin. Wooden pins must be used in growing trees. In dead timber or poles a $\frac{1}{2}$ in. bit is used for the $\frac{1}{2}$ in. square standard wrought iron tree pin.

Attaching insulator to pin.

42. The tie wire is cut into lengths of about 30 inches 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 inches long, the end 3 inches 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.

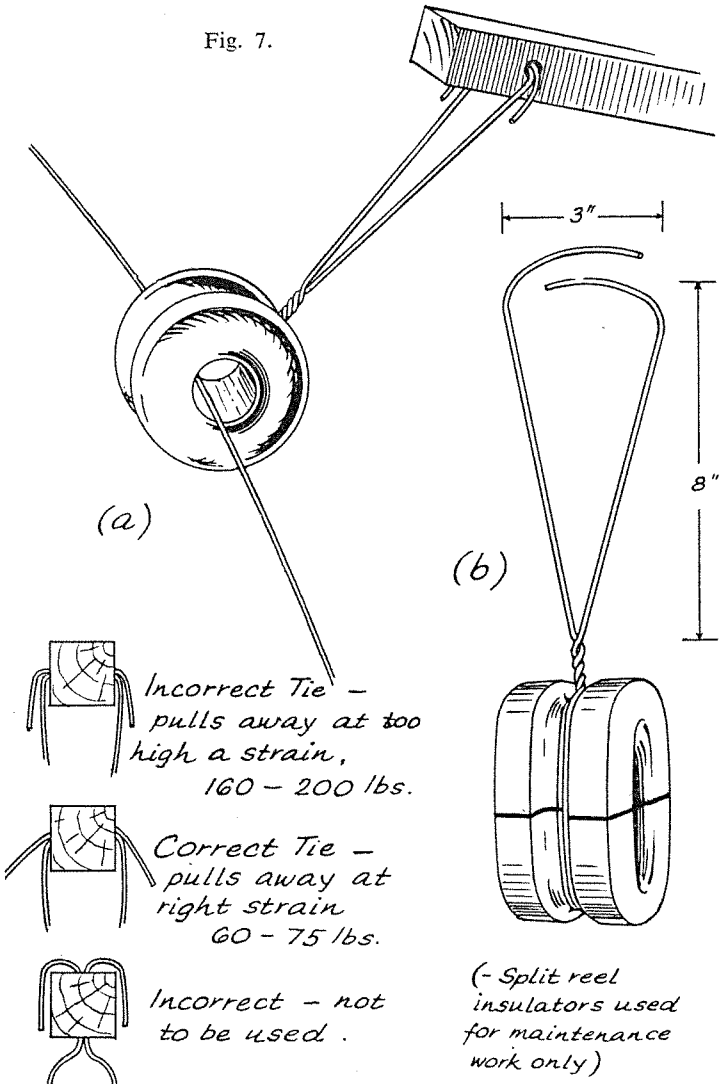


Fig. 6.

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 10 feet should be a minimum.

The following figures will serve as a guide:—

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

The line should have an average span of 2 chains, an average sag of 5 feet and an average clearance at mid span of 12 feet. A down pull of 35 to 50 lb. 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.)

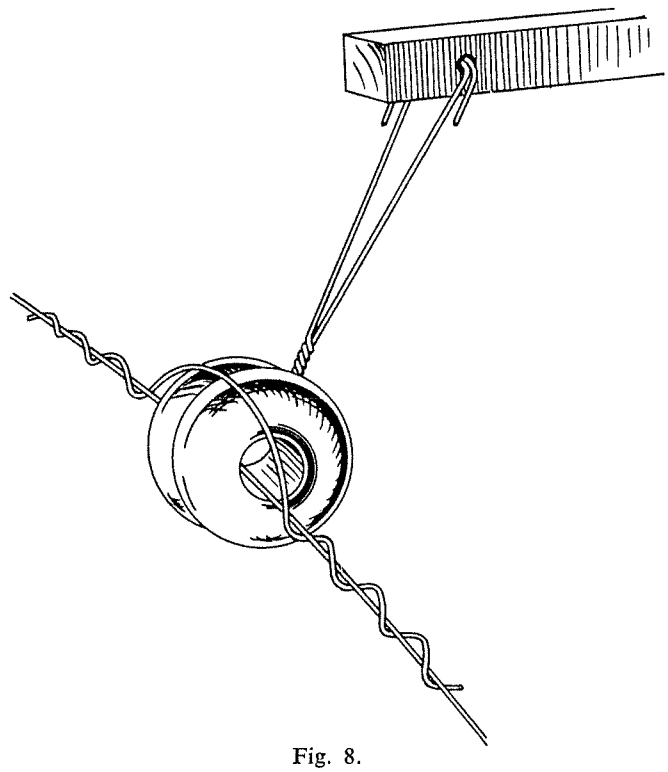


Fig. 8.

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 160 feet 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.

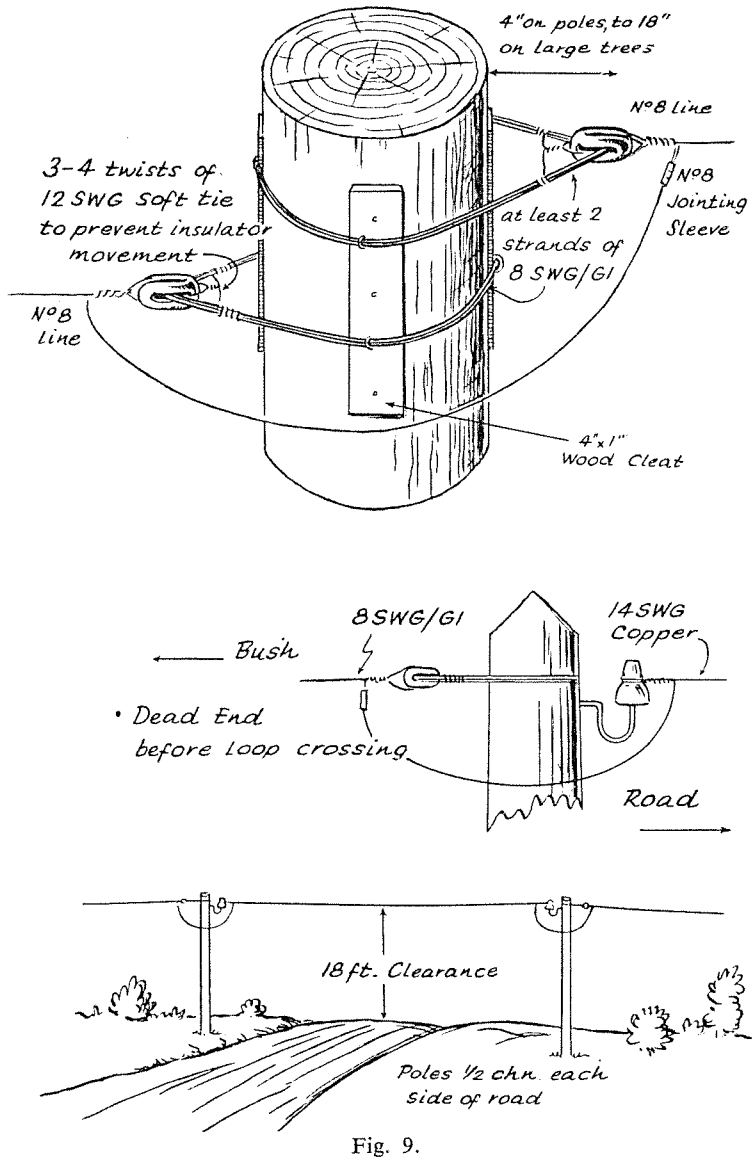


Fig. 9.

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 inches. Dead-ending on poles.

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.

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 in. hole about 6 inches 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 21 feet long, with a top diameter of not less than 6 inches (including sap wood). The base is cut off square and sap wood is removed Poles.

to a height of 5 feet 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.)

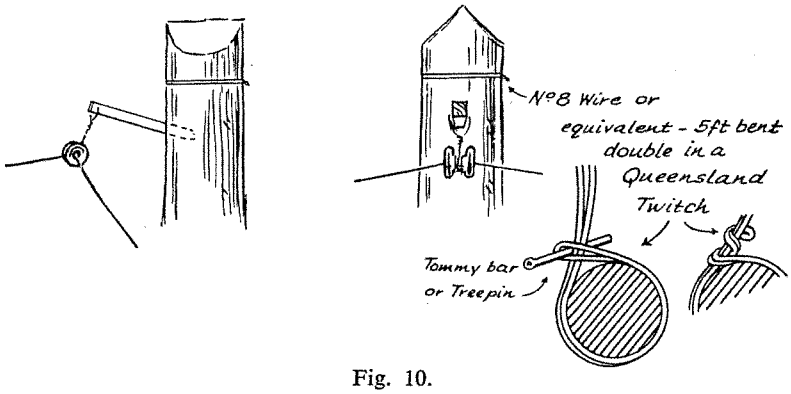
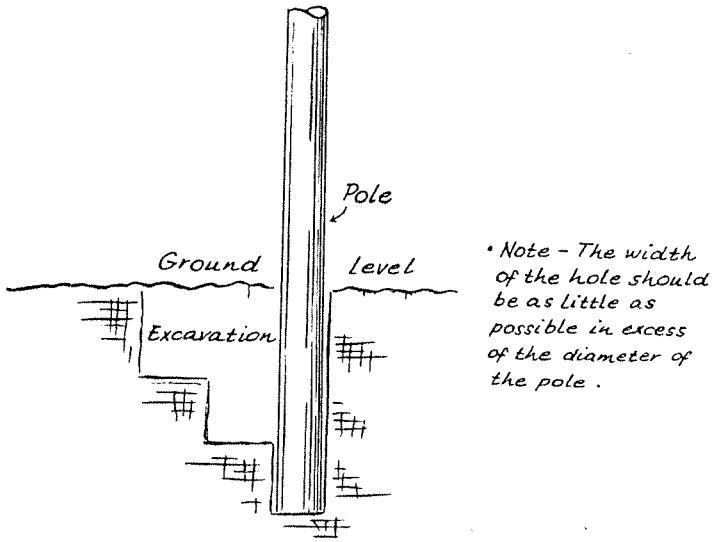


Fig. 10.

Digging holes.

48. Holes at least 6 inches 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 4 feet. 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 in. board is placed at the back of the hole to receive the butt and guide it down. The pole is "trued" after about 6 inches of earth has been trampled down around the base and the hole is then filled in and the soil packed down. About 6 inches 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 22 feet above the metals.

(ii) The span across the railway must not exceed 60.4 m.

(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 18 feet.

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

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

Any poles erected with an overall length of 24 feet 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.

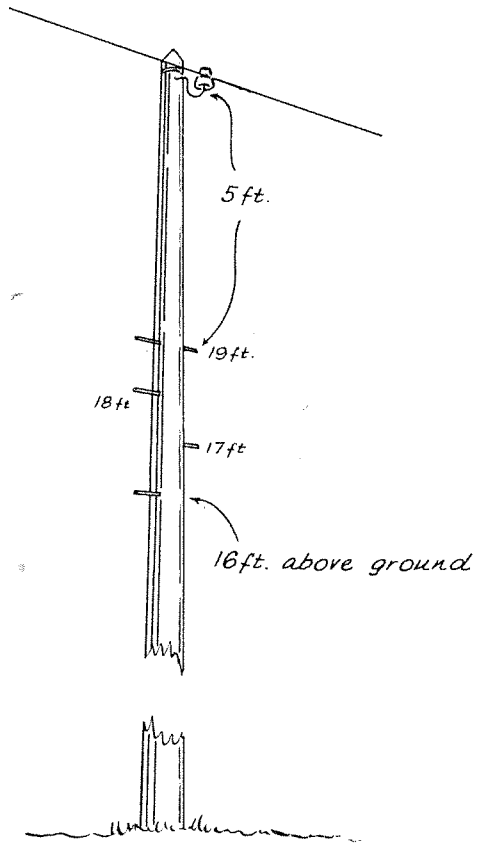


Fig. 12.

52. On curves or angles the poles may be raked to offset the pull, but with the slack tree line this is not necessary, unless the pull exceeds 15 feet. (See Fig. 13.)

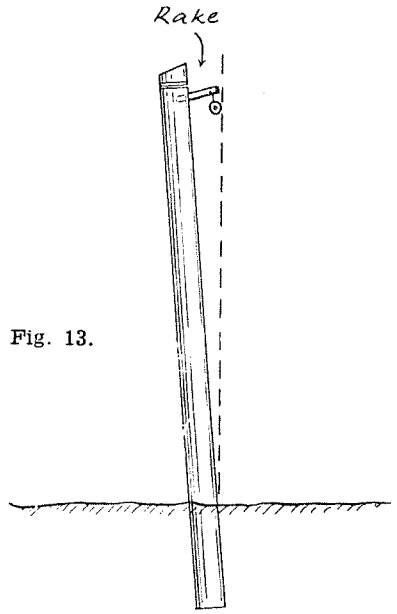

Rake

Fig. 13.

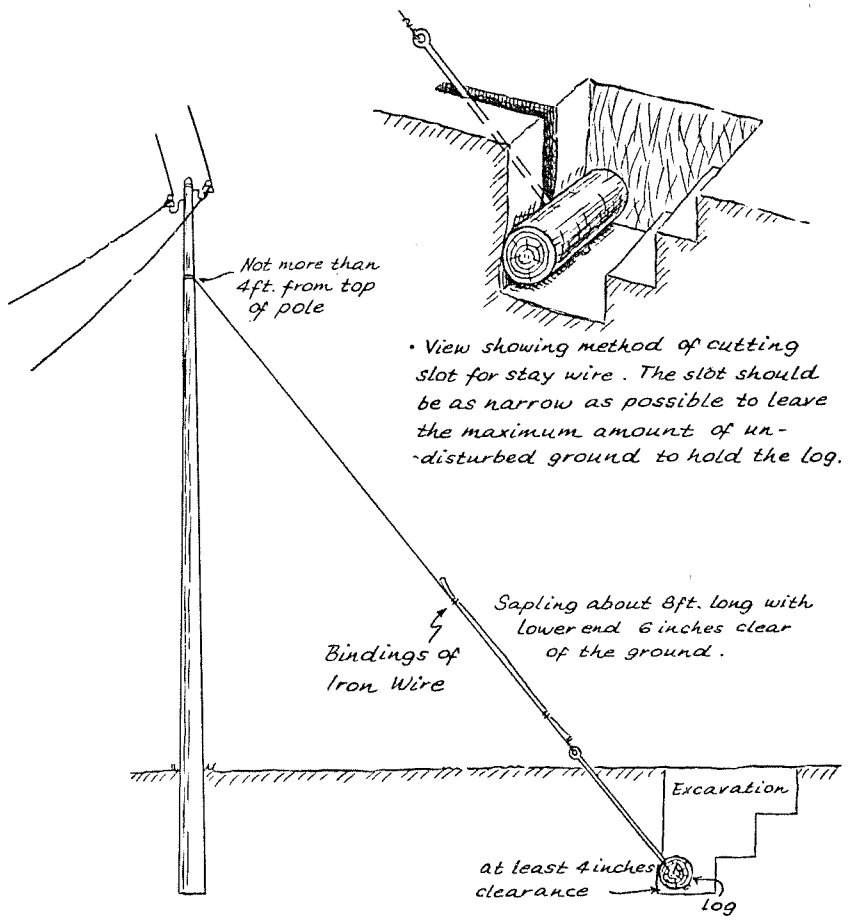

Not more than 4ft. from top of pole
View showing method of cutting slot for stay wire. The slot should be as narrow as possible to leave the maximum amount of un-disturbed ground to hold the log.
Sapling about 8ft. long with lower end 6 inches clear of the ground.
Bindings of Iron Wire
Excavation
at least 4 inches clearance
log

Fig. 14.

Stays.

53. Poles will be stayed—

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

(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 inches to 6 inches 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.)

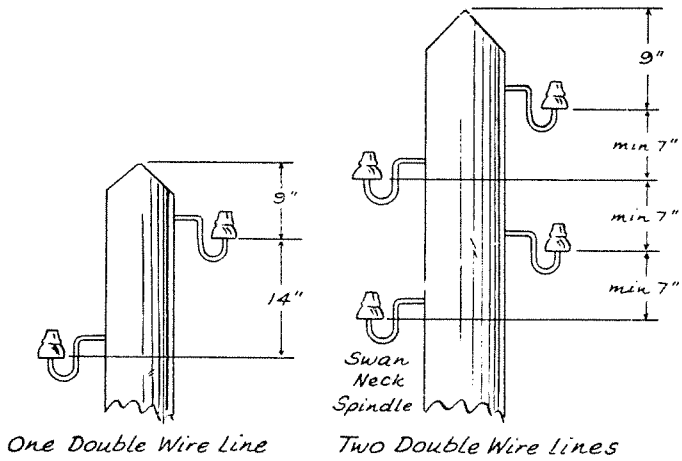


Fig. 15.

Where possible a space of at least 12 inches is desirable between insulators, but this may be reduced to 9 inches 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.)

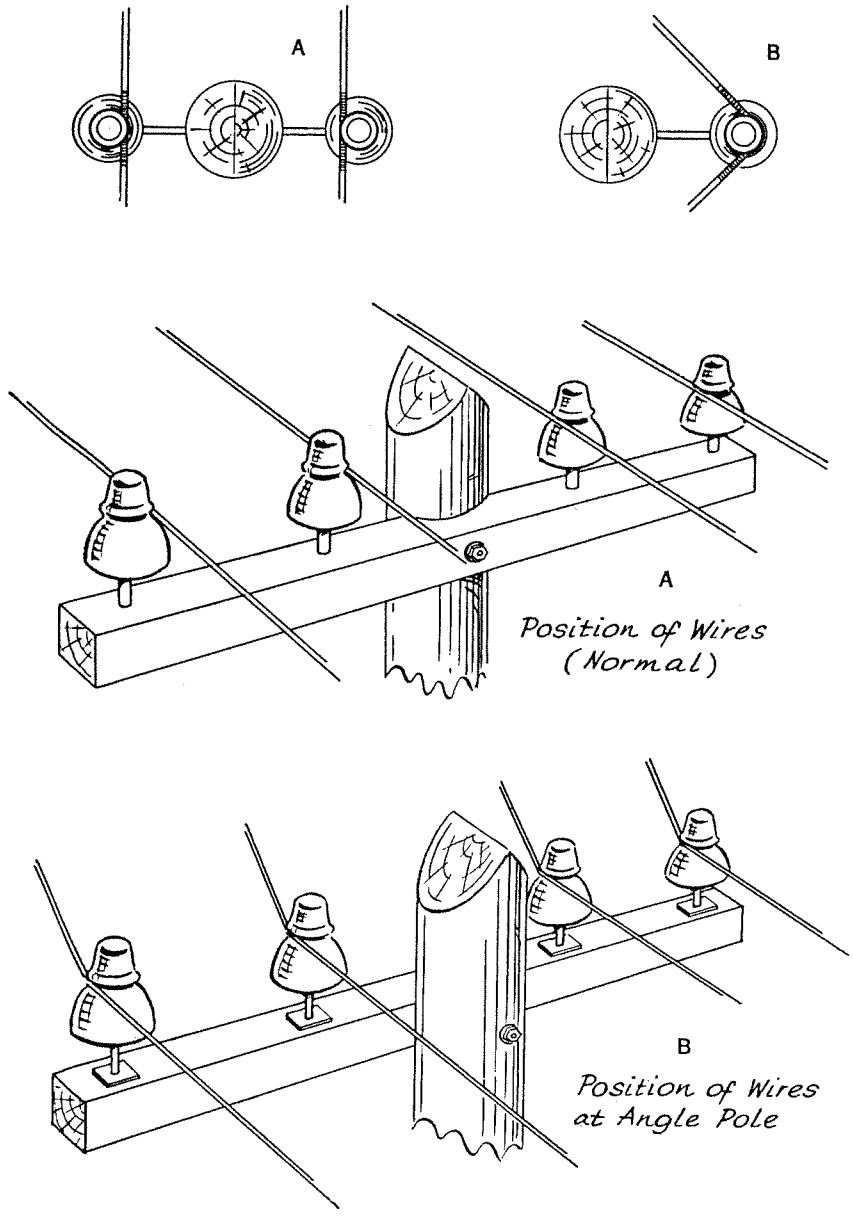


Fig. 16 (a) and (b).

Attaching line wire to insulator.

59. Figure 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.*

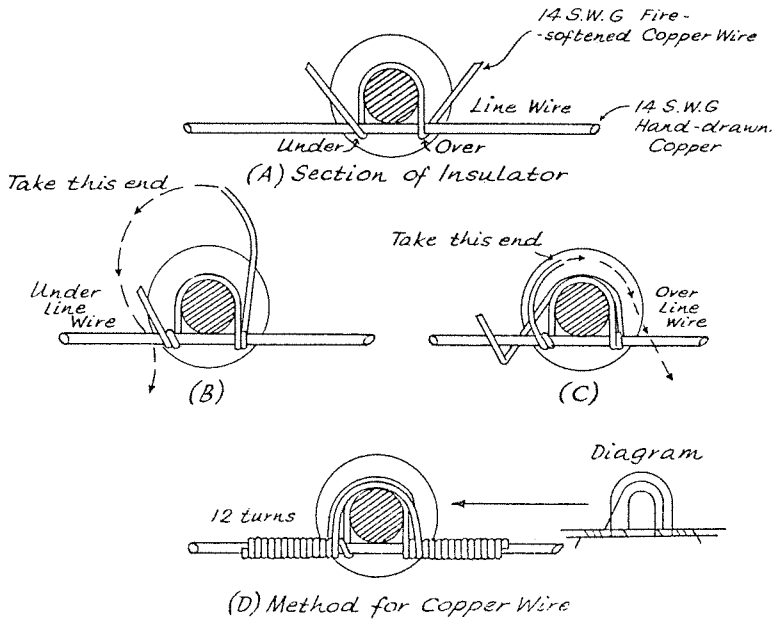


Fig. 17.

60. Figure 18 shows the standard method of terminating a taut copper wire. Terminating a line.

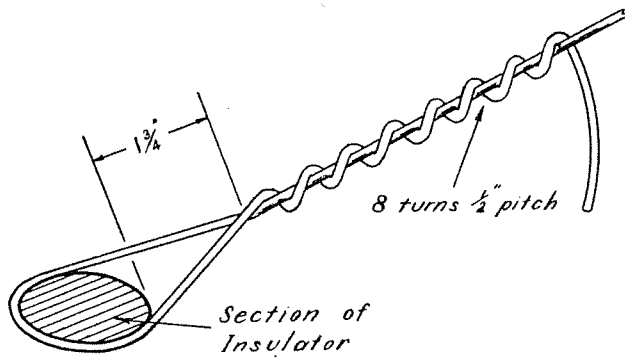


Fig. 18.

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

Sag for Copper Wire.

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

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

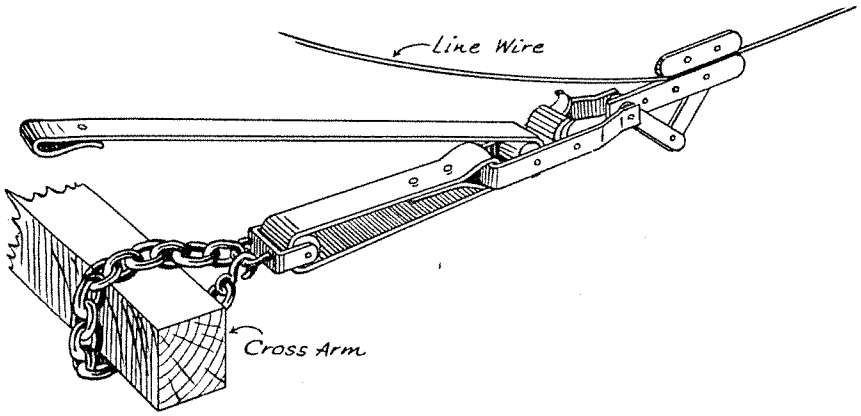
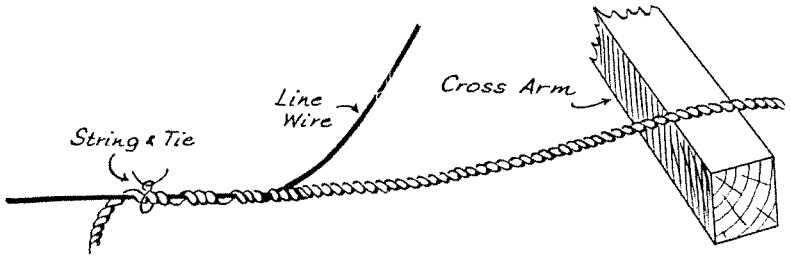


Fig. 19a and b.



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 attaching 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 feet or more high, with 3 in. x 3 in. cross arms and wire spacing 12 inches or 16 inches. 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 it well done.

Insulators.

67. The insulators on corner poles should be fitted with ½ in. 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 3 feet to 9 feet to carry from 2 to 14 wires. For uniformity and

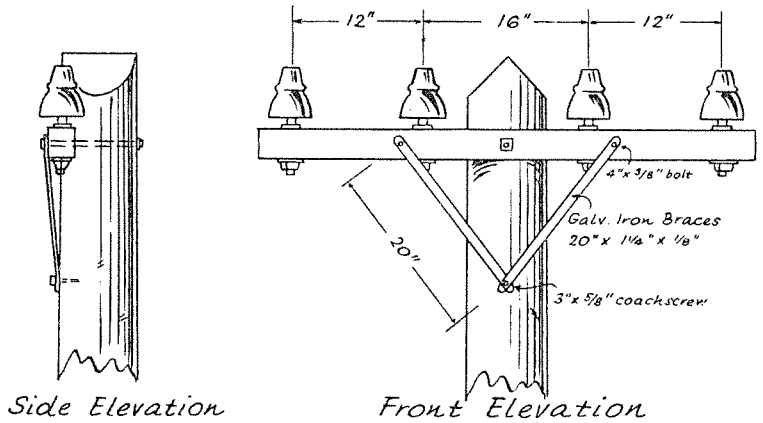
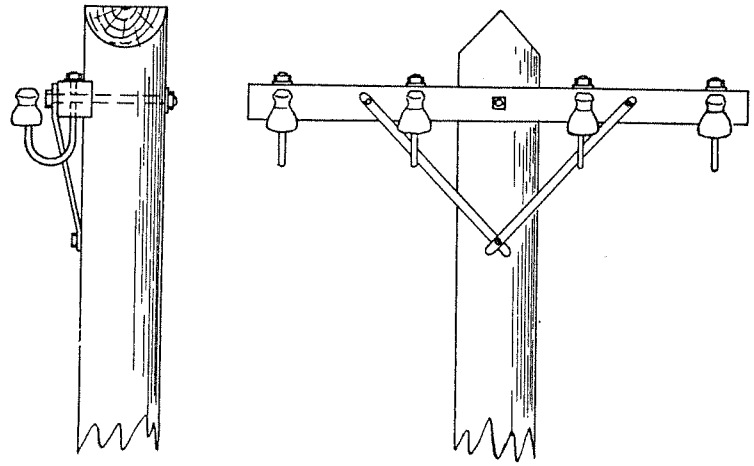


Fig. 20.

good appearance, cross arms on the same pole and on the same line of poles should be all the same length, but on branches from the main line where fewer wires are to be carried the length of arms may be reduced.



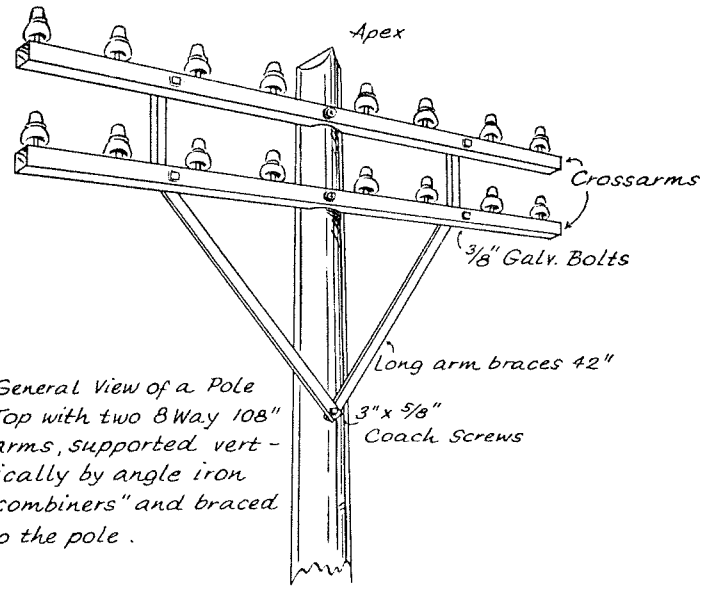
Side Elevation Front Elevation

"J" Bolt Termination

Fig. 21.

71. Cross arms shoud be of sound seasoned hardwood 3 inches x 3 inches 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 arms, the poles should be slotted to a depth of from 1 to 1½ inches and the cross arm should be secured to the pole with a ⅝ in. bolt as shown in Fig. 22. A coach screw 3 in. x ⅝ in. 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.



General View of a Pole Top with two 8 Way 108" arms, supported vert--ically by angle iron "combiners" and braced to the pole.

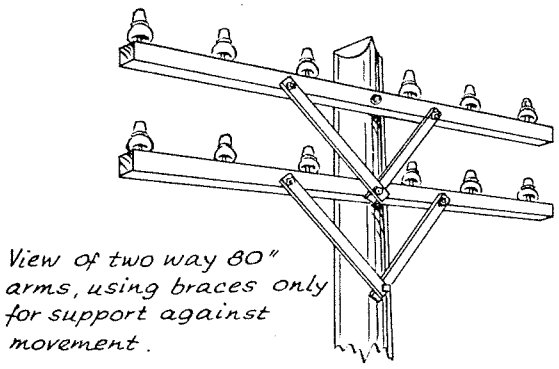

View of two way 80"
arms, using braces only
for support against
movement.

Fig. 22.

LINE TESTING

General

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.

It is important to test the transformer at the end of the line before line testing begins.

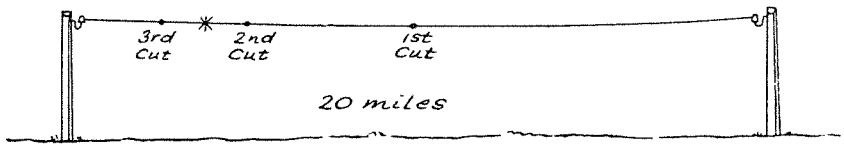


Fig. 23

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 a boundary and branch switches are:—

(i) To connect a branch (1 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 two lines earthed.

Link 3 and 4.
Link 1 and 2 and 5.

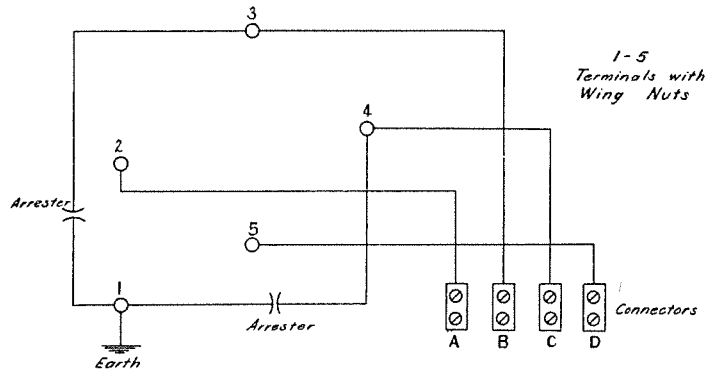


Fig. 24.

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.

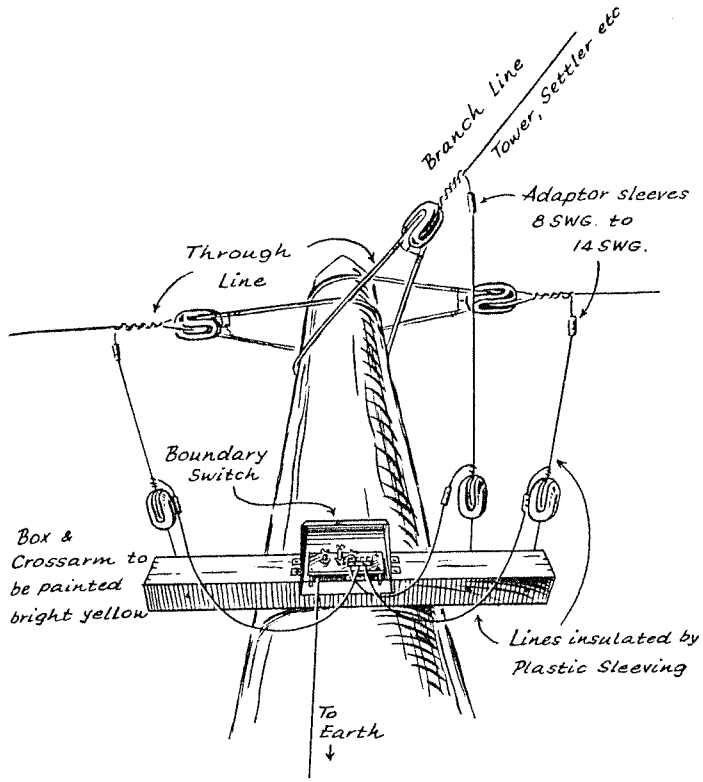


Fig. 25.

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:—

Description of the transformer system.

Well clear of the settlement each incoming bush line is terminated in an "unbalance to balance" transformer. (See Figs. 26 and 27.)

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

It will be noted 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.

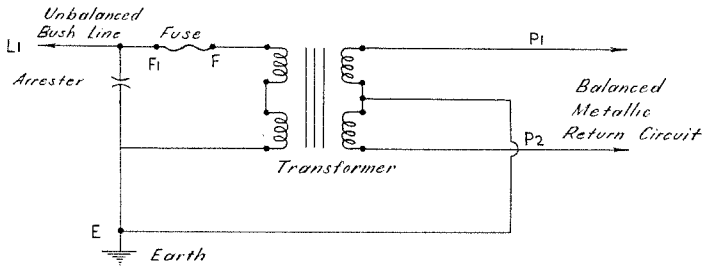
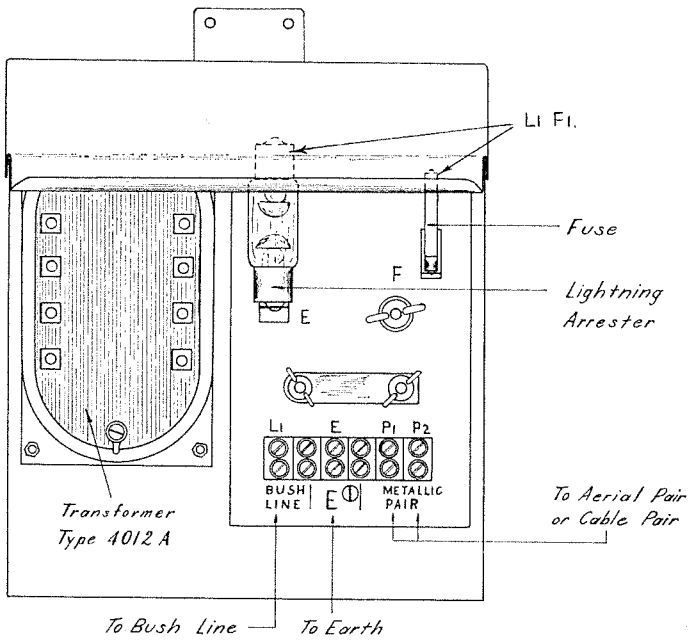


Fig. 26.



Line Transformer with Lightning Protection

Fig. 27.

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 30 feet long should be carried and each end of these cables should be terminated by a 25 amp. battery alligator clip. Covered auto cable 3 mm P.V.C. 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

Telephones

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 rinking crank handle is turned it operates a switch which connects 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.

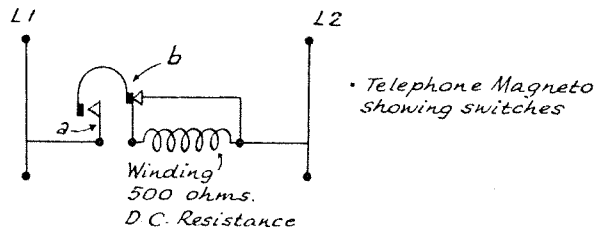


Fig. 28.

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.)

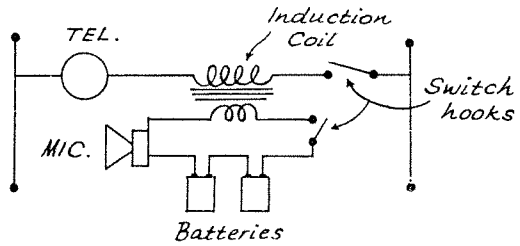


Fig. 29.

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 frequences 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 generally 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 the 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 are filled with Argon or Neon gas. (See 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.

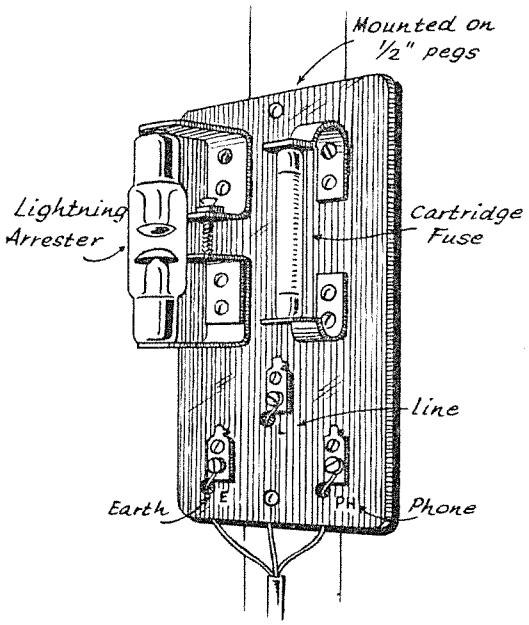


Fig. 30.

Switchboards

97. Switchboards are manufactured at Radio Branch and are built and wired to suit each particular installation. Installation is carried out by a Radio Branch technician.

98. In almost all large settlements wiring is now placed underground. Protection against lightning is now placed at the line transformer (see para. 79) near the settlement boundary.

99. A switchboard usually consists of one row or more of key switches arranged horizontally.

Each line occupies one switch in the row. At the right-hand end of the row an answering switch is placed. When an extension bell rings indicating a call, that line switch is pressed down, the answering switch is pressed down to connect the caller to the switchboard attendant. The caller then asks to be connected to another line. The attendant presses down the line required, operates the generator to call the party. When the party answers, the operator returns the answering switch to the "off" position.

When another call arrives at the switchboard the attendant again carries out the above procedure but pushes the switches up instead of down.

One row of switches can carry two conversations. If more than two calls are required to be answered at any one time, this is achieved by duplicating the top row of switches. This will provide four conversations through the board which is usually sufficient.

To overcome magneto cranking internally in settlement systems, push-button buzzer systems are usually substituted for magnetos.

100. Tower switchboards (Fig. 31) are usually mounted so that they can easily be removed from towers during the winter months. During removal they should be stored in a lined storeroom to protect them against moisture and corrosion.

101. Before removing wires from tower switchboards, holes should be punched in a piece of hard cardboard, cut and spaced to the shape of the row of line connectors at the top of the switchboard.

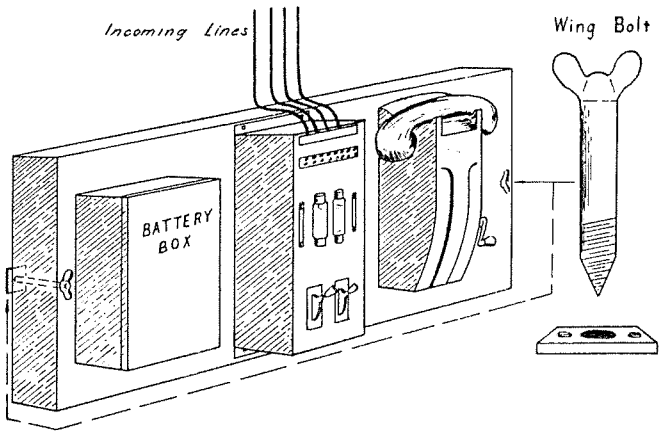


Fig. 31.

102. As each wire is removed it should be passed through the corresponding hole in the cardboard strip. This procedure will simplify connection next fire season.

103. Batteries *must* be removed from tower switchboards while in winter storage.

Telephone Earths

104. 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.*

Selection of the most suitable earthing site in the vicinity of an installation can be chosen, with certainty, with the aid of an earth resistance meter. This instrument is kept at Radio Branch for the purpose.

The benefits of careful earth selection are often not fully appreciated. Poor speech level, loss of ringing current, bells tinkling on other lines, are symptomatic of a poor earth connection, which is particularly noticeable during a dry summer.

Earths for lightning protection.

105. 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 waterpipe 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.

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

The best telephone earth.

107. The most effective method is to bore a hole into a suitable earth site with a post-hole digger between 4 inches and 6 inches diameter. The hole should be as deep as possible (say, 10 feet to 20 feet). 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. 32.)

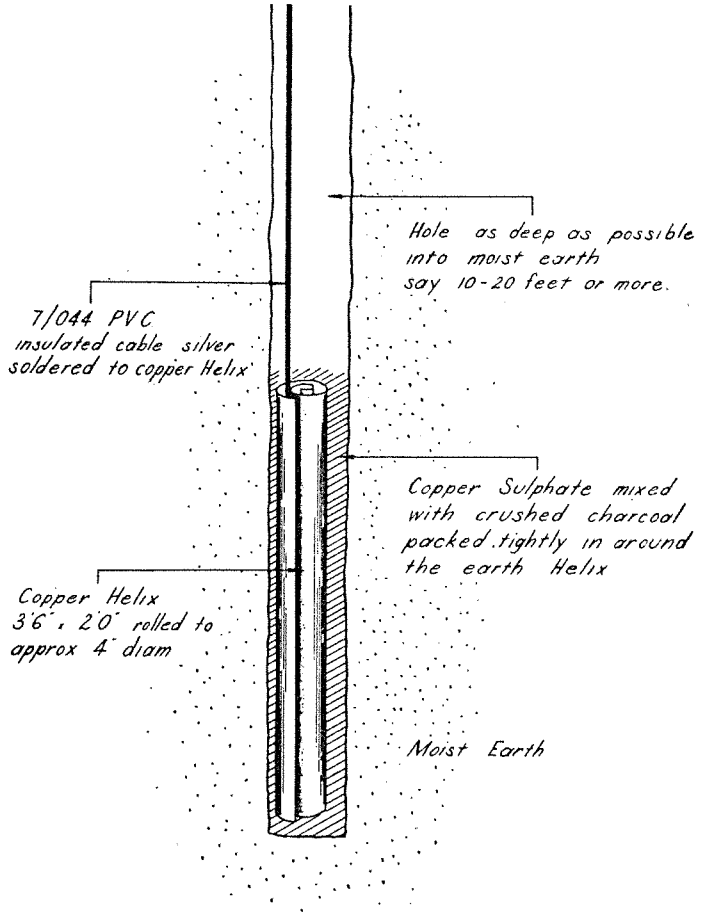


Fig. 32.

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.

108. Figure 33 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.

The undesirable results of poor earthing.

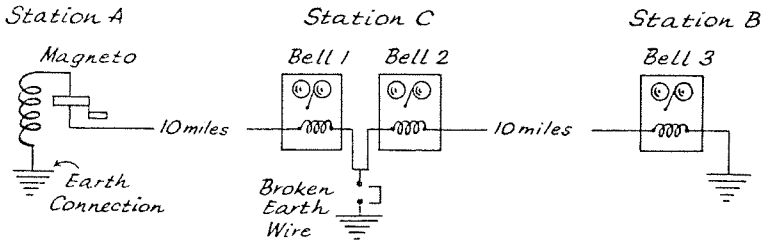


Fig. 33.

(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.

109. 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.

FAULTS AND FAULT FINDING

Indoor Installation Troubles (Earth Return Systems)

Testing telephones.

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

111. 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.

112. 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.

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

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

Earth connections.

115. 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.

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

117. 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. 34.)

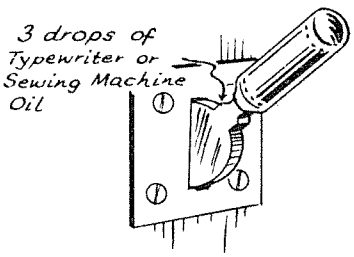


Fig. 34.

Bush Lines

118. Procedure should follow method outlined in para. 73. Referring to Figs. 26 and 27, it can be seen that by removing the fuse this separates the settlement from the bush line.

119. The line transformer may be defective. Using two field telephones, connect one to F and E the other to P1 and P2. Test by ringing and talking through the transformer. Then test to the switchboard.

120. The results of these tests should show whether the fault lies in the bush, the transformer or the settlement.

In the Settlement

121. The principal faults are:—

(a) Short circuit or partial short circuit.

(b) Open circuit.

Short circuit.

122. A short circuit is indicated when the ringer (or magneto) handle is very hard to turn, while an open circuit puts no load on the ringer and the handle spins easily.

123. The office switchboard can help to isolate faults by virtue of switching, but where a number of telephones are across one line, as in the case of the "House" line, only by removing telephones singly can the fault be located.

In these cases, remove one wire of the pair connecting the telephone and crank the ringer handle. A short in the phone will put a heavy load on the cranking action.

124. If after removing each phone in turn fails to lift the fault, the trouble is possibly in the cabling.

Open circuit.

125. Where open circuits on a line are suspected, connect a field phone across the line and test. This will determine whether the phone or the line is at fault.

126. Although it is possible for simple faults to be located without expert knowledge, the settlement cabling system should never be interfered with. After carrying out the above simple testing, if the fault still persists the Telecommunications Officer should be advised immediately.

Lightning.

127. After a severe lightning storm a setlement telephone system should be thoroughly tested to detect any faults or drop in performance. High voltage from lightning strikes can cause short circuits in telephones, burn or fuse together key switch contacts or cause short circuits in boundary transformer.

Severe damage of this nature can only be repaired by skilled technicians.

Fuses.

128. Line protection fuses sometimes blow after a lightning storm.

The arms holding fuses become corroded and often through use hold the fuse with weak pressure. When this occurs they should be cleaned and bent carefully to provide more contact pressure.

UNDERGROUND CABLING IN SETTLEMENTS

129. Many of the settlement overhead metallic return installations have in recent years been removed and underground cables substituted. For efficiency and to save a considerable amount in annual rental, P.M.G. extension telephone wiring is also incorporated in F.D. settlement cabling.

130. Another pending development is extended local control, within a settlement, of radio telephones. This will allow the officer on duty at home outside working hours to operate the radio telephone installed in the office from his house.

131. Layout of underground cabling, together with office switchboards and extension switchboards, are prepared by the Telecommunications Officer and installed by a telephone technician.

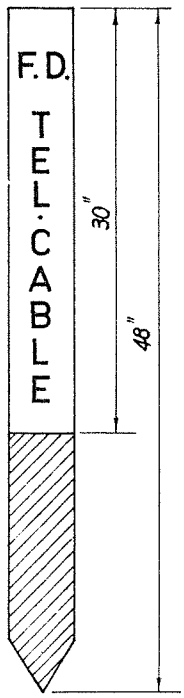
132. Briefly, the installation comprises one office switchboard and three house switchboards with full facilities for all bush lines. Up to six 2-line switchboards may be approved, providing house line and key tower line to houses for after-hours duty officers.

133. All too frequently underground cables are cut and damaged by settlement excavation or cultivation, resulting in loss of service and expensive replacements.

Cable routes run underground must be protected as follows:—

(a) Trenches must be at least 24 inches deep.

(b) In gardens, under roads or in areas where damage by digging is likely, telephone cables should be enclosed in old water piping or placed under concrete slabs.



SPECIFICATIONS
4"x 1½" Dressed Jarrah
Undercoat: Red Lead
Top Section: White Gloss
Letters: Black Gloss
Letter Size: 2½"
Bottom Section: Creosote or Bitumen Paint

Underground Telephone Cable Marker

Fig. 35.

(c) Cable routes should be marked and clearly indicated with a cable marker. (See Fig. 35.)

(d) An up-to-date plan of all underground cables should be kept in the office for consultation before excavations are made in the settlement.

(e) Permission from the Officer in Charge and "approval to proceed" must be obtained before any excavations are made in a settlement.

(f) Although there is a tendency for radio-telephones to supplant earth return telephone lines, this has little effect on settlement underground cables, which are needed for the P.M.G., radio telephone smoke-reporting messages, and telecommunication needs within a settlement.

P.M.G. Cabling in a Settlement

134. It has been arranged with engineers of the P.M.G. for the Forests Department to provide, install and maintain all underground telephone cables within a settlement.

135. This arrangement saves the Department a considerable amount in annual rental charges each year. The cost of installation to P.M.G. requirements is small, as it only involves a few pairs in each cable run for the comprehensive bush telephone system.

136. Where a P.M.G. telephone instrument is required at an extension point, the cables to provide the service are brought out of the main cable and terminated in a small wall connector block. The P.M.G. technician makes his connection to this block.

137. At the office a special connector strip is made available for the P.M.G. technician to connect the office switchboard.

138. It is so arranged that it is never necessary for the P.M.G. technicians to interfere with the F.D. cabling system at settlements.

139. In the case of faults occurring in F.D. cables used for P.M.G. circuits, these faults are corrected or other serviceable cables are made available by the Forests Department.

140. When repairs, alterations or extensions of telephone services are required at a settlement, the Telecommunications Officer should be notified so that he can co-ordinate the work. Head Office prior approval is required for alteration and extensions as it involves expenditure outside of estimates.

141. The only person permitted to install, repair, maintain and test F.D. cables is the Telecommunications Officer or his staff.

142. Complete records of underground cabling and terminating connections are kept at Radio Branch.

APPENDIX "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 36
2	Insulator, Porcelain, Split Reel....	For replacements of broken line insulators. See Fig. 36.
3	Insulator, Porcelain, Skirted small	3 in. maximum diameter skirt, 3 in. high, body threaded 8 turns per inch, 1 in. diameter. See Fig. 36.
4	Insulator, Porcelain, Skirted large	3½ in. maximum diameter skirt, 4 in. high, body threaded as for Item 3 above. See Fig. 36.
5	Insulator, Porcelain, Guy Strain (Egg insulator)	1⅝ in. diameter, 3 in. long. For telephone dead ends and radio aerials. See Fig. 36.
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. 36.
6a	Spindle, galvanised steel "J" bolt	For use with insulators on terminating poles. See Fig. 36.
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. 36.
8	Spindle, Wooden	Wandoo with ⅞ in. shank for use with Item 3. For use with 3 in. x 3 in. crossarms. See Fig. 36.
9	Pins, Wooden	Wandoo with ⅝ in. shank. For hanging tree lines with Items 1 and 2. Used in growing timber. See Fig. 36.
10	Pins, Steel	For hanging tree lines with Items 1 and 2. Used in poles. Made from mild steel ½ in. square. See Fig. 36.
11	Wire, Telephone, No. 8 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. 37.
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. 37.
13	Wire, Tie, G.I., Soft	12 s.w.g. galvanised soft iron. For insulator ties. See Fig. 37.
14	Wire, Tie, 14 s.w.g., Copper	This is Item No. 12—Fire softened. Used for tying lines to insulators, Items 3 and 4. See Fig. 37.
15	Sleeves, Jointing, No. 3	Used for jointing No. 14 s.w.g. copper wires. See Fig. 37.
16	Sleeves, Jointing, No. 11 (b)	Used for jointing No. 8 s.w.g. G.I. wires. See Fig. 37.
17	Sleeves, Adaptor	Used for jointing No. 14 s.w.g. copper to No. 8 s.w.g. G.I. See Fig. 37.
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. 37.
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	Ericsson N1845K 2000 ohm with 3 watt magneto. See Fig. 38.
25	Telephone, Table, N2124 B8T, Long Cord ; N2124 B7T, Short Cord	Standard table telephone. See Fig. 38.
26	Telephone, Wall Telephone, N2206 B7T, Long Cord ; N2206B6T, Short Cord	Standard wall telephone. See Fig. 38.
27	Cells, Dry, 1·5, Eveready No. 6, 6½ in. high x 2½ in. diameter	Wall and table telephones, Items 25 and 26.
28	Cells, Dry, 1·5, Eveready x 71	For portable telephones, Item 24.

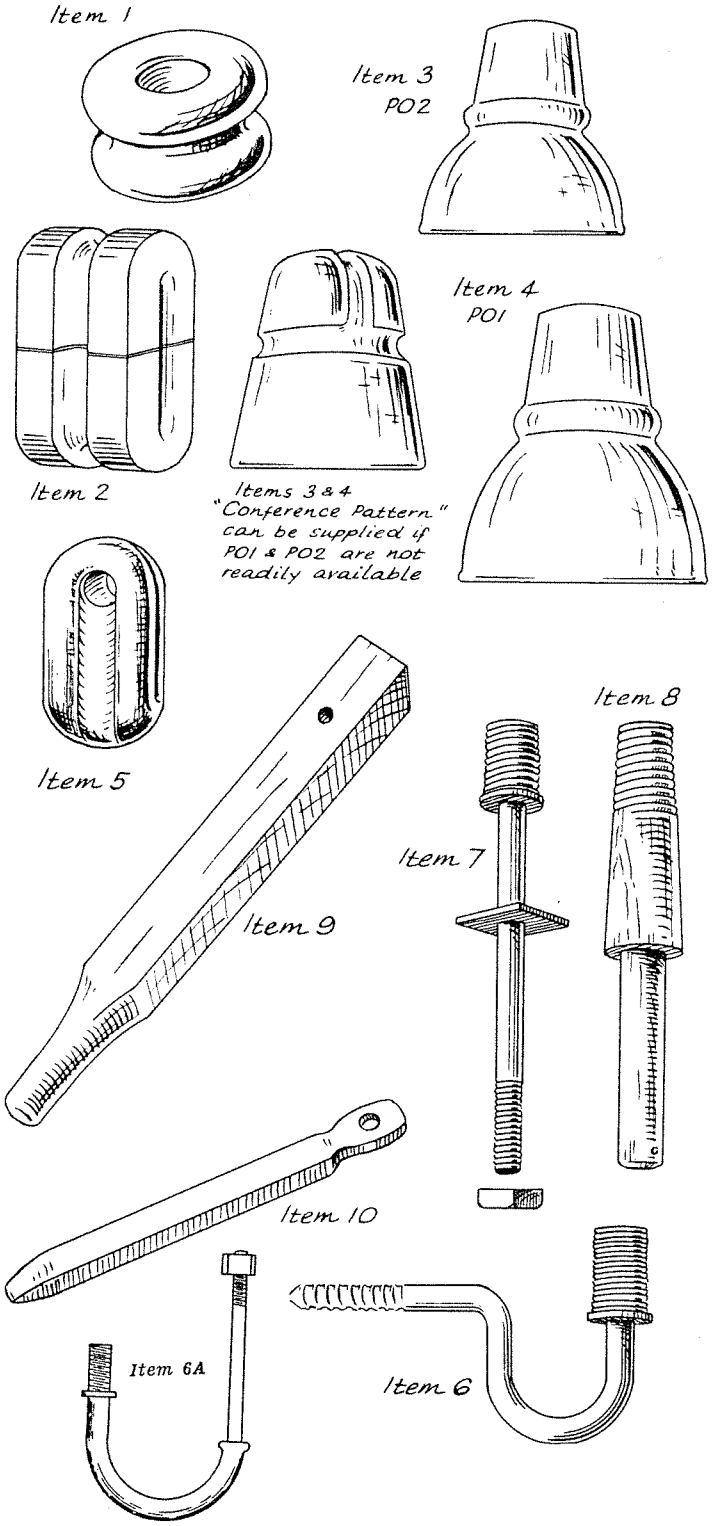

Item 1
Item 3
PO2
Item 4
PO1
Item 2
Items 3 & 4
"Conference Pattern"
can be supplied if
PO1 & PO2 are not
readily available
Item 5
Item 8
Item 7
Item 9
Item 10
Item 6A
Item 6

Fig. 36.

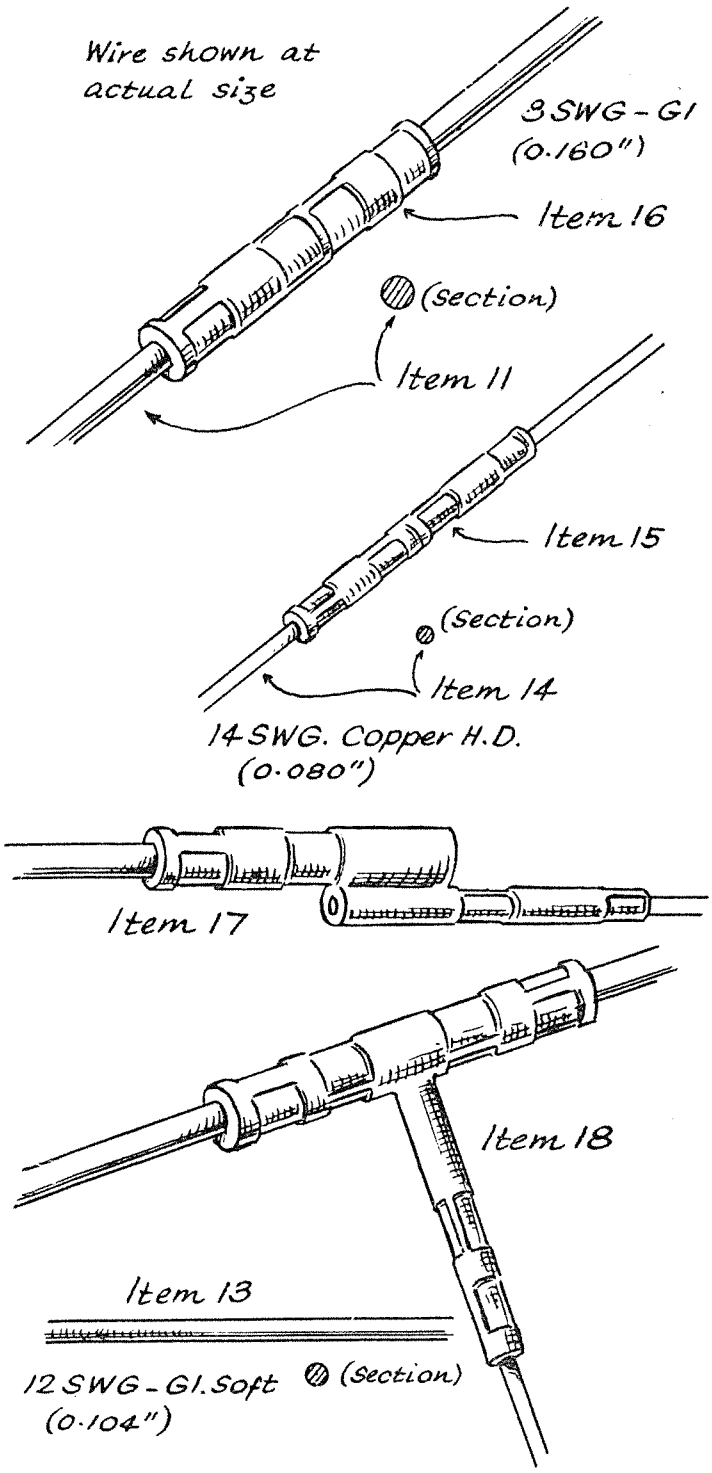

Wire shown at actual size
3 SWG - G1 (0.160")
Item 16
(Section)
Item 11
Item 15
(Section)
Item 14
14 SWG. Copper H.D. (0.080")
Item 17
Item 18
Item 13
12 SWG - G1. Soft
(Section)
(0.104")

Fig. 37.

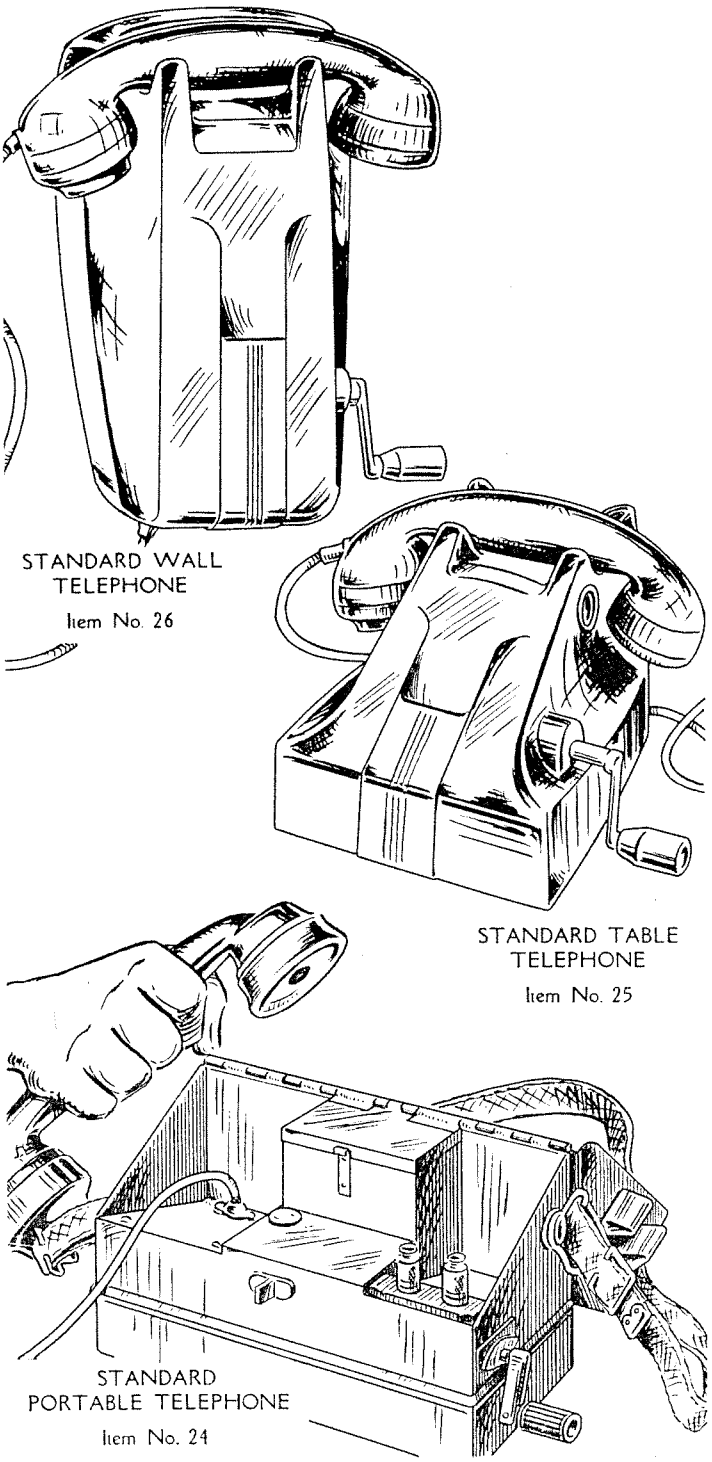

STANDARD WALL
TELEPHONE
Item No. 26
STANDARD TABLE
TELEPHONE
Item No. 25
STANDARD
PORTABLE TELEPHONE
Item No. 24

Fig. 38.

APPENDIX "B"

GENERAL DESCRIPTIONS OF TELEPHONE TYPES

While a few of the older British and Swedish Ericsson telephones are still in use, they are only used in situations where the increased efficiency of the modern Ericsson's type is not necessary.

The current models of telephone in use are—

(1) Table Telephone Magneto.

Type (a) No. 2124 B7T short cord.

(b) No. 2124 B8T long cord.

In design and performance, these telephones are far in advance of the telephones they replaced. The main feature is a heavy duty ringer (magneto) with an output of 5 watts, a 60 per cent. increase, while the speech circuits perform better.

The telephone batteries are mounted in a separate metal box usually mounted on the table leg or skirting board in the case of the table type. In the case of the wall-mounted phone, the battery box may be mounted in any convenient position. The batteries are connected in series, that is, any one wire to positive of one battery (centre terminal), while the other wire is connected to the negative of the other battery. The remaining positive and negative terminals are connected together with a small jumper wire.

Batteries must be renewed every 24 months. The date of renewal should be written on each battery.

Connections are as follows:—

Wall Types:

Line 1 to terminal 1.

Line 2 to terminal 9.

Connect battery wires to terminals 1 and 8 (any polarity).

The handset is connected as follows:

Green wire to terminal 6.

Red wire to terminal 5.

White wire to terminal 4.

Table telephones differ in that they are provided with a flexible connecting cord and 4-terminal connecting box.

Connection in the boxes are—

Line 1 to Red.

Line 2 to White.

Battery wire to Green.

Battery wire to Blue.

Red and Green are bridged with a metal strip.

For guidance, each telephone has a sticker affixed to show connections:—

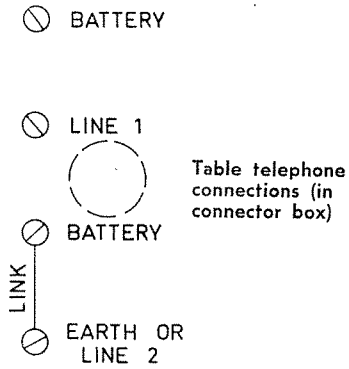


Table telephone connections (in connector box)

TELEPHONE CONNECTIONS

TERMINAL No. 1 EARTH
TERMINAL No. 1 BATTERY
TERMINAL No. 8 BATTERY
TERMINAL No. 9 LINE

Wall telephone connections (inside the telephone)

In the interests of hygiene, telephone handsets should be cleaned using a plastic cloth immersed in detergent and warm water. Methylated spirits or Dettol may be added. The body of the telephone and handset is wiped with a cloth rung out damp with the solution. Unscrew the ear and mouthpiece and thoroughly wash in the solution. Dry them before screwing back into place.

Ericsson Portable Telephones

These telephones are housed in a strong steel case painted brown. A shoulder strap is provided for carrying. A cradle switch is not fitted; in its place a thumb switch is provided on the handset for disconnecting the batteries when the phone is not being used.

Portable telephones have two main uses:

(a) Line and apparatus testing.

(b) Temporary connections to bush lines.

A field phone may be substituted for any other telephone when a fault is suspected.

Exension bells can be checked with the ringer.

Line transformer boxes can be checked using two portables.

The field telephone is invaluable for line-testing in the bush. A heavy load on the handle indicates a grounded or shorted line while an open circuit or cut line is indicated by no load on the handle.

When it is desired to use a temporary telephone point in the bush, an earth may be generated by driving a spike or axe into the sappy butt of a tree. Two or more bonded spikes in different trees will increase the efficiency of the earth connection.

When an earth connection is used, ensure that the earth is connected to L2 terminal on the telephone. Batteries should be renewed every two years. When batteries are renewed, write the date of renewal on them.

These telephones seldom develop faults. Almost all faults encountered are due to abuse of the telephone by storing it in places without cover. Usually water enters the case and causes extensive damage. When carried in vehicles these telephones must be protected against dirt and water entry.

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