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Post Office Engineering Department

TECHNICAL PAMPHLETS FOR WORKMEN

Subject

Open Line Maintenance

ENGINEER-IN-CHIEF'S OFFICE
1919

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OPEN LINE MAINTENANCE

(H 3)

The following pamphlets in this series are of kindred interest :

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OPEN LINE MAINTENANCE

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OPEN LINE MAINTENANCE

The efficiency of the telephone service depends in a very large measure upon the through-going maintenance of the open lines. These are essential links in the chain of communication, and it may at first sight seem unnecessary, therefore, to insist upon their importance. One link in a chain is of no more or less importance than another, but an impression is rather widely held that the duties associated with line maintenance are somehow a little inferior to other maintenance duties. They are different in kind, but they are not less important. Whether we regard only the foresight required in the intelligent anticipation and prevention of faults in their incipient stages, the careful thought necessary in planning out maintenance work in order to ensure the systematic examination of the entire line plant in a lineman's maintenance, the patience requisite in tracking down a fleeting fault, and the skill, agility and endurance in every-day faulting; or whether we regard the higher capital cost of line plant as compared with that of trunk, junction or subscribers' instrument ends, we reach the same conclusion, that line maintenance is by no means an inferior duty. On the contrary, it is a duty requiring the exercise of qualities of body, and mind of a superior order, and without these, or with their half-hearted exercise, the telephone service would seriously suffer.

1.—PATROL OF LINES.

On the principle that prevention is better than cure, a maintenance man who discovers and removes a defect which would otherwise cause a fault and the stoppage of a circuit is entitled to greater credit than he who does not. The ideal condition of line maintenance is an absolute freedom from faults, and although this cannot be attained in practice even by the best of linemen, it can be very nearly reached, and often is, by minute and systematic attention to the duty of line patrol.

A line maintenance man should never be content with merely walking his lines and taking notes of work to be done "some other day." "Do it now" is an excellent rule. If there is a defect that, for excellent and sufficient reason, cannot be remedied at once, and a note must be taken of it, it is desirable to enter it in the note book with which a competent lineman is provided, and not on a scrap of paper, which has a habit of losing itself when most required.

Appropriate tools and sufficient stores to remedy defects brought to light on patrol duty **must of course be carried.** The problem presented by the weight of these is in course of solution with the introduction of motor cycles and sidecars for the use of linemen. Meantime, a lineman's zeal for the credit of the Engineering Department and his own will induce him to observe a wise middle course between carrying too little and

leaving important maintenance work undone because he has insufficient tools or stores, and carrying too much and fatiguing himself to such a degree that he fails to see incipient trouble which he could rectify, there and then, had he been in a condition of greater alertness. Systematic patrol does much to abate the arduousness of line maintenance—an insufficient clearance between line wire and stay, J bolt, branch of tree, etc., corrected to-day may save a ten-mile ride against a head wind to-morrow, or a number of faults being reported and not found.

Successive examinations of main lines should be made in opposite directions. If the first examination is made from A to B, the next should be made from B to A.

On patrol, **a lineman scans every part of the line plant,** and if he has unavoidably to take his eyes off the line to negotiate road traffic, he picks up again at the point where he took them off. Failure to do this has often led to the passing of an incipient or actual fault. A good lineman takes nothing for granted, and resolves every doubt as he goes along. If the mind is disturbed with the thought, " I wonder if I passed it at the corner pole? " or " It might have been in those trees," the attention is distracted and further thorough examination becomes difficult. Thoroughness leads to confidence, and confidence of this kind promotes thoroughness. Make sure that a fault, or what might cause a fault, has not been passed.

Poles fitted with stays, with or without crutches, are specially productive of faults. The pull of the wires, aided from time to time by wind pressure, tends to deflect the pole from its upright position and bring the line wire in contact with the stay. Sometimes the clearance is so slight that, while a fault may not exist when examined, the heat of a summer's day will cause expansion and consequent lengthening of the wire, and a fault result; or in wet weather, the slight clearance may be bridged by rain water. On stayed poles a loose arm in canting over also brings the line wire in contact with the stay. Stayed poles, therefore, and especially newly-stayed poles, require to be closely watched.

Leads and leading-in wires at cross-over poles, at pole test boxes, and into testing offices, need to be kept under close observation, so that early intimation may be obtained of any deterioration and steps taken to ensure their prompt renewal.

If a few individual poles are climbed every time a patrol of a particular route is made, and precise **information gleaned of the condition of binders, earthwires of poles and arms,** all of which, when in a broken or defective condition, are prone to cause faults, not only will immediately impending faults often be prevented, but the necessity for renewal on a larger scale than the lineman can undertake will be made plain and steps towards renewal taken. Great importance is attached to the intimate

knowledge which a lineman may acquire by systematic inspection of individual poles.

Patrolling reveals any want of **regulation in the wires,** and it is one of the many merits of a good lineman that he has a specially trained eye for the instant perception of the slightest want of regulation, and can follow a particular pair of wires on a heavy main route without hesitation and without being confused by the presence of a large number of other circuits. Carefully made joints are necessary to ensure efficient working.

A look-out should be kept for branches, kite strings, etc., resting amongst the wires.

Wires crossing railways demand especially careful maintenance. A close examination of the terminations at either side will early disclose weakness and obviate the danger and risk of accident involved when a wire falls across the permanent way. Deterioration due to smoke from locomotives may be often observed, and in this event early renewal is called for.

Trees are a prevalent source of trouble, and efficient maintenance cannot be expected while there is want of ample clearance between trees and wires. When on patrol linemen should gather all possible information from landowners, residents, roadmen and others regarding trees which are or may be the cause of faults, carefully noting it for immediate or future reference. Tree-cutting is a matter of some delicacy, and difficulty with landowners and tenants can be avoided only by strict attention to instructions on the subject.

During construction every effort is made to erect **wires clear of chimneys,** the smoke from which causes deterioration more or less rapidly depending upon the nature of the fuel used. Close attention to the line where it is affected by smoke or any chemically active fumes will make a lineman aware when there is need to renew.

It is rather a rare occurrence for properly **creosoted poles** to rot, but they nevertheless require to be kept under observation. Any **doubtful pole is sounded** with a hammer. If the pole emits a hollow sound on tapping it is an indication of internal rot.

Damage to insulators is occasioned by stone-throwing which in some localities amounts to a serious nuisance. Systematic patrol will keep such localities under special review, and an abatement of the nuisance may generally be secured if the police are kept fully posted as to the damage being done and are urged from the proper quarter to discover the offenders. One or two convictions advertised by means of cautionary notices usually suffice to bring about an improvement. It is necessary to renew without delay all insulators damaged to such

an extent that they are no longer efficient. If there is any doubt in a particular case whether it is safe to allow a chipped insulator to remain and the circuit is an important one, the doubtful insulator should be replaced.

Pole Test Boxes require frequent examination to ensure that all carbons are clean and thumb-screws tight, fuses tightly fitting and test holes clean.

Wall Plates to which stays are fixed also need frequent examination. **Stays anchored in ashes** suffer rapid deterioration if the tar and tallow compound is not renewed from time to time—a minor job which can conveniently be done when patrolling lines, etc.

There are other items in connexion with line plant to which it is desirable to give close attention on patrol which can only be briefly summarized here:—

(a) **Stays** not taut, or liable to touch wires; **saddle fixings** at a corner pole. Where wires change from 4-way to 8-way arms, they must be maintained in good regulation in order to reduce the risk of contacts. The method to be adopted is shown in Technical Instructions XIII; (b) branches or other foreign bodies across the wires; (c) the 50 lb. tinned copper wire which leads into Insulators No. 14 should be soldered to the tag and not screwed under the fuse-holder screw—a make-shift arrangement sometimes adopted which leads to varying conductivity faults; (d) the condition of raw hide suspenders on aerial cable routes; (e) the condition of over-house standards and their supporting stays—any deterioration due to rust calls for early chipping and repainting; (f) arms out of square, loose, decayed or split; (g) odds and ends of metallic articles or pieces of wire which, being near to hand, may be thrown upon the line by children should be prudently put out of sight; (h) insulators so dirty as to cause substantial loss of insulation; (i) the condition of painted poles or lagging; (j) building or other operations which may affect the line in any way.

Among miscellaneous matters which it is necessary to note may be mentioned poles or stays which have been left in a condition dangerous to road traffic as a result of road widening operations, and power circuits which have been recently erected in proximity to the Department's lines. (The Postmaster-General's approval is necessary before such power circuits are erected, and if a maintenance man has not had prior intimation of the new power circuit he would do well to call attention to it.) Impending tree-felling operations as evidenced by numbered trees, building operations likely to interfere with the wires, or flags which may foul them, bills irregularly posted on the poles, road-closing orders which may affect the Department's

plant—all are things which should be noted in order that there shall be no failure to take proper steps.

The lineman who is keen on attaining a high standard of maintenance does not hesitate to make suggestions which he thinks will improve maintenance conditions because there may be some doubt as to whether it is his business to do so or not. He knows that anything that affects his maintenance affects his credit, and it must therefore be *his* business, no matter who else may have responsibility in the matter.

2.—LOCALIZATION AND CLEARANCE OF FAULTS.

Before the subject of " Faults " can be profitably discussed there are certain elementary ideas as to the meaning of a few electrical terms which must be mastered. For this purpose the current of electricity flowing in a wire is generally compared to a current of water flowing in a pipe. Water flowing in a pipe is impeded to some extent by the friction at the inner surface; in other words, there is **resistance.** If there is greater resistance there will naturally be a less rapidly flowing **current,** unless the **pressure** behind the water be made greater in a like proportion. Electrically, pressure is only another name for **electromotive force.** We have thus the three terms necessary for the simplest statement of Ohm's law, which states that the current is directly proportional to the electromotive force and inversely proportional to the resistance; or, more simply, current increases as the pressure increases, and decreases as the resistance increases. As the rate of flow of water passing through a pipe is measured in some unit of quantity (say, a gallon) flowing in some unit of time (say, an hour), so electricity is measured in a unit of quantity (Coulomb) passing in a unit of time (one second); but instead of saying " Coulombs per second," we say " Ampères." Similarly, we think of resistance in " Ohms," which is the unit of resistance, and of electromotive force in " Volts," which is the unit of pressure. There are other terms in common use, and useful notions of them may also be gained by analogy with a water pipe. If we suppose that the inside of the pipe is very smooth so that the water is conducted along with little or no obstruction, we may say that the pipe possesses great conductivity; if there is some movable obstruction that now and again partially stops the flow, we may say there is " varying conductivity "; if the obstruction is such that it completely stops the flow, we have a " disconnexion." Further, if the water oozes through in a sort of dew, as if the pipe was slightly porous, we may correctly think of it as having " low insulation." Insulation is only another word for isolation. The porous material

does not isolate the water in the pipe, but allows it to soak through. If the water trickles through cracks or holes the pipe has a " leak," the electrical equivalent being an " Earth fault." If all the water leaks away we have the equivalent of a " Full earth."

With these simple ideas clearly impressed on the mind we shall consider the faults which occur in actual practice and note the various causes, one or more of which generally give rise to specific faults. It will be assumed that the reader has made himself acquainted with the use of the Lineman's Detector which will be fully described in another pamphlet in this series.

The faults to which lines are subject are various modifications of the following:—

(i) **Disconnexion.**	(v) **Varying Conductivity.**
(ii) **Earth.**	(vi) **Noise.**
(iii) **Contact.**	(vii) **Induction.**
(iv) **Low Insulation.**	(viii) **Short Circuit.**

(i) **Disconnexion,** as the name implies, is caused by an actual break at some point of the circuit. The line wire may be broken through deterioration or by a fallen bough, or by flying debris from a blasting operation, or by the impact of a heavy bird. Breakages of Trunk wires, however, from these or similar causes are comparatively rare; they are frequently caused by careless construction such as: binders twisted too tightly, wire kinked or pulled up too tightly in hot weather, and insufficient clearance at gateways. Disconnexions are most likely to be found at a blown fuse or a broken lead at some leading-in pole or Pole Test Box. Fuses sometimes break as a result of road vibration, and links at testing points sometimes escape replacement after having been removed to give a disconnexion for a testing office. During a lightning storm there are generally many fuses blown, and the fact can as a rule be detected on inspection and all faulty fuses replaced quickly without test. It is a wise precaution to test all fuses after such a storm with one dry cell and detector. If there is any doubt whatever that the blown fuses may be due to causes other than lightning, a test for high potential should be made.

The method of making a test for a disconnexion is illustrated in Fig. 1. No deflection indicates that the line is disconnected. In practice, there will often be some slight deflection or kick. If indications are carefully watched, a little

experience will generally enable the lineman to make a shrewd guess as to the probable distance of the fault.

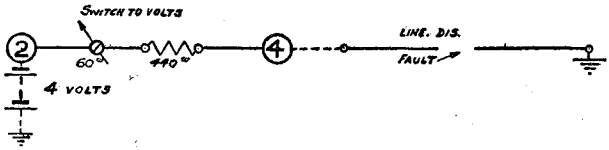

Fig. 1.

Men maintaining small exchanges must, of course, be acquainted with their circuit diagrams. Without a knowledge of circuit connexions at both the Exchange and the Subscriber's ends, the observed indication on the detector will often be misleading. As this pamphlet has chiefly in view the needs of men on line maintenance, only one illustration of this will be given. See Fig. 2, which represents a CBS Subscriber's circuit. The A line is disconnected at the fuses, although a first examination of the fuses by the lineman has revealed no obvious discon-

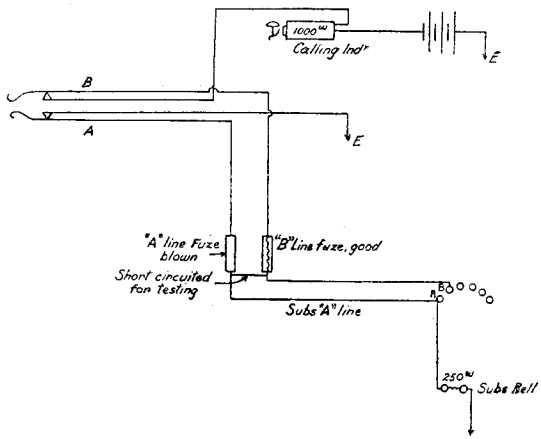

Fig. 2.

nexion. He places a loop across the line, on the Subscriber's side of the fuses, and finds that he can call the Exchange. If he therefore concludes that the loop is complete on the Exchange side, and that accordingly, the disconnexion must be somewhere towards the Subscriber's end, he will be wrong. The reader will be able to see for himself that the circuit of the earthed Exchange calling battery is completed via the A line and the earth on the Subscriber's bell.

After disconnexion due to an actual break in, say, a 200 lb. copper wire or one of heavier gauge, the lineman may have some difficulty in temporarily regulating the wire to avoid contact or short circuit. In such a case, sufficiently good regulation can be ensured by adopting the following procedure:— Lengthen the wire by connecting a piece of double 60 lb. G.I. binding wire, a small quantity of which is almost invariably carried. Unscrew the insulator two or three turns, pull the wire up hand-tight, complete two turns of the loose end round the insulator and pass it under the line wire, screw up the insulator whilst pulling on the free end of the wire, and make fast. Fig. 3 shows the matter plainly.

The fiddler's joint there illustrated is permissible only quite near to the insulator, where its projection cannot possibly give rise to contact.

Broken terminations. especially of 40 lb. wire, are difficult to trace. Owing to the two or three twists which are made after the wire has been passed round the neck of the insulator, they do not allow the wire to spring free, and therefore appear to be all right when viewed from the ground. The circuit in such cases is intermittently disconnected, noisy and of varying conductivity.

A careful examination of the line sometimes reveals the fault. If this fails, the best method is to loop one end of the line, connecting a battery in series, and leave the other end

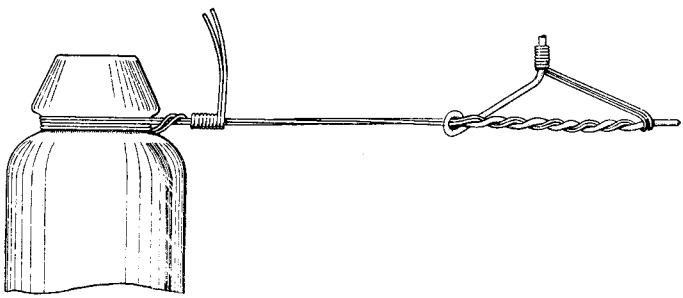

FIG. 3.

disconnected, then to proceed over the line and place the detector across at some convenient point. If a telephone receiver is used instead of a detector, the intermittent disconnexion will be heard.

When a **through 40-lb. wire is discovered broken,** it can be "picked up" without the aid of a vice, thus: Clean the wire a

few inches from the ends of the break and thread a jointing sleeve on each end. Join a piece of 60-lb. G.I. wire temporarily to each end, as illustrated in Fig. 4, and pull the wire into

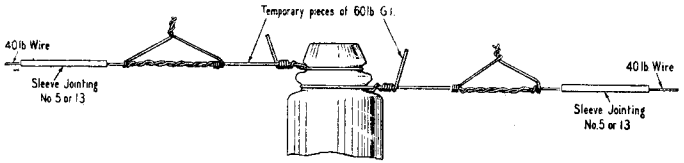

Fig. 4.

regulation with pliers. The piece of new wire to be inserted can then be joined by means of jointing sleeves and the wire bound in to the insulator. Fig. 4 illustrates the operation.

(ii) **Earth.**—Any cause which permits of leakage to ground or earth results in an earth fault. One or other of the follow-

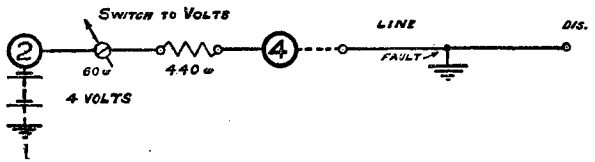

Fig. 5.

ing causes may be confidently looked for: The line wire may be touching a stay or crutch, or touching another wire normally earthed for signalling purposes such as CB and CBS or Telegraph circuit. The wire may have come off an insulator and be lying on an arm; or faulty lighting protectors and damp leads may be the cause. The existence of an earth fault may be proved by the detector test illustrated in Fig. 5. A wire on a stay or crutch will generally give a steady deflection, but a varying one will be observed, as a rule, if the line wire is lying upon an arm. Trees seldom give rise to a full earth. Saplings touching a line wire in the spring will give a "partial earth" indication. Carbon Protectors require special examination and careful replacement after lightning storms; but apart from storms, these will cause earth faults, if carelessly maintained. The heavy currents on main line telegraph circuits set up

partial earth faults at the carbon plates, if the surfaces of these are not kept smooth and clean. It is a good plan to clean the inner faces with fine Emery and to rub in a little French Chalk.

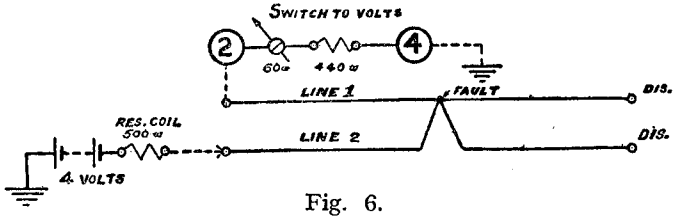

Fig. 6.

(iii) **Contact.**—This fault is occasioned by one circuit touching or otherwise making electrical contact with another. Very high winds or excessive heat will sometimes bring wires in fair regulation into contact, or they may be whipped into contact by a swinging branch. Contact may be effected by means of a loose end of wire or other metallic body which has been thrown upon the wires, or by a wire falling off its insulator. A joint towards the centre of an abnormally long span will in a high wind also bring about a contact fault. Bad regulation is a frequent cause. An **appearance** of bad regulation is produced when some of the wires concerned are bound in on the wrong side of the insulators. A test for contact is given in Fig. 6.

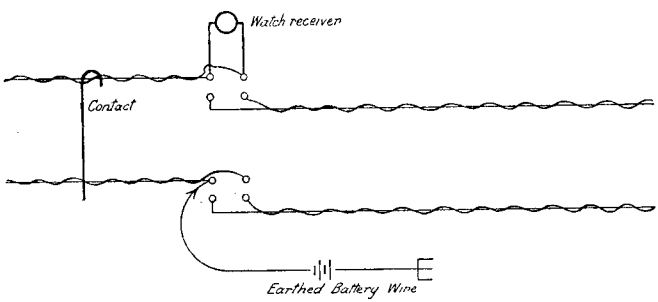

Fig. 7.

A contact fault, as usually reported, makes it clear which two circuits are concerned, but if only one of them is noted in the Fault Advice, the lineman will find it convenient to discover the other as a first step. This he can do by tapping round

the adjacent wires at the test box, as illustrated in Fig. 7, with an earthed battery wire. A click in the watch receiver will indicate when the other circuit has been found. A reference to the pole diagram book will already have made apparent the circuits probably concerned, and only these need be tapped round.

Where routes branch, or wires change their squares, the names of the circuits in contact will often suffice to indicate the correct sub-localization, for the reason that contact generally, but not always, takes place between wires in adjacent squares. Inexperienced men sometimes have difficulty in identifying a contact in spans when no foreign body or very obvious entanglement or twist can be seen. At the point where they cross when seen against the sky the wires always at first sight seem to be touching. Whether, however, they are, or are not, can be easily determined. If they *are*, the point of contact will not move;

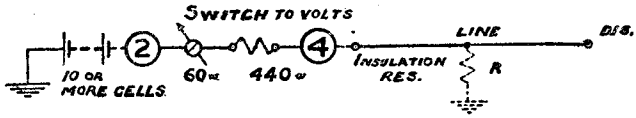

Fig. 8.

if they *are not* but only appear to be, the point of apparent contact will oscillate gently to and fro however little wind there may be, and about the apparent contact there will flicker to and fro an irregular patch of brightness as the dark line of the crossing wires moves against the light of the sky.

Tree contacts are generally intermittent or tapping contacts, and the indications are the same as for varying insulation, unequal insulation or partial earth. C.B. lines are frequently made unworkable by tree contacts.

(iv) **Low Insulation.**—This fault is a special case of " earth," the fault being an earth of high resistance. It may be caused by deteriorated leads, wires touching poles, arms, trees, roofs of houses or stay wires.

How to make a test for insulation is indicated in Fig. 8.

(v) **Varying Conductivity.**—Probably the most prolific cause of this kind of fault is the dry joint. Other causes are the line wire broken in binder, bad office connexions, and corroded conductors at leading-in points, dirty links and test holes, dirty fuse caps and clips and damp fuses in fused insulators.

(vi) (vii) **Noise and Induction.**—Wherever we have unequal electrical conditions as between one wire and another in the same pair, noise or induction or overhearing, or all three, may be observed. The telegraphic induction or overhearing associated with

unequal electrical conditions between A and B wires is always much less pronounced than the indications of true contact.

(viii) **Short Circuit.**—This is a special case of contact. Instead of two circuits being concerned, the A and B wires of the same circuit are in contact. The causes are generally similar to those giving rise to true contact.

Working parties may cause all and every kind of fault unless the greatest care is taken by the foreman and the men under him.

(ix) **Recurring Faults.**—Finally, as regards recurring faults, if a fault is definitely localized on several occasions to the same length of line without adequate cause being revealed, it is desirable to make a special examination in detail before the fault is again reported.

3.—TREE PRUNING.

Substantial tree lopping generally falls to the lot of a construction party, but has occasionally to be undertaken by a lineman with assistance. A lineman, however, is required to do systematically such pruning as is reasonably practicable for him.

Before pruning or lopping is commenced, consent must be obtained from owners, or from duly accredited agents, and if the trees overhang the road or street certain formalities prescribed under the Telegraph (Construction) Act of 1908 have to be observed.

It is important that the trees should be lopped in a proper manner so as to avoid undue injury to their growth. The following rules, if carefully observed, will secure immunity from complaints of bad husbandry:—

The leading shoot of a young tree—that is, the shoot which ultimately forms the trunk of the tree—should, if possible, be preserved. Regard should be had to the general aspect of a tree. When the removal of a number of branches from one side has given the tree a markedly unbalanced appearance, its symmetry may often to a great extent be restored by removing some branches from the opposite side.

Branches which have to be removed entirely should be **CUT OFF CLOSE TO THE TRUNK.** No stump should be left; and when it is necessary to remove a portion of a branch it should be taken off at the "fork." This applies more particularly to branches three inches or more in diameter. Fig. 9 shows what is meant.

The dotted line A shows the proper place at which the cut should be made. In cutting or sawing off a branch it is sometimes more convenient, or may indeed be necessary, to cut from D to A instead of from A to D. When the course of the cut has to be from D to A, the bark will be first

cut transversely at A, in order to obviate the tearing of the bark downwards from A, which otherwise is apt to occur when the branch falls. It is wrong to cut at B or C, because snags would be left.

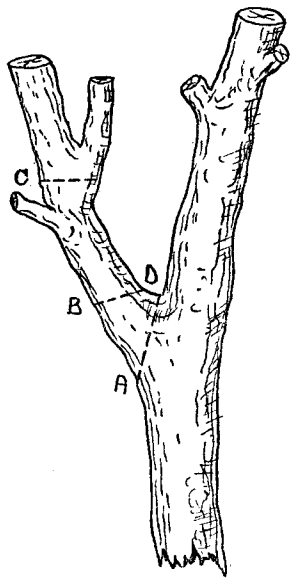

Fig. 9.

All wounds made by the removal of limbs or branches should be coated over with ordinary coal tar before the tree is finally left.

Trees with a dry wood, like oak, hornbeam, and beech, may be pruned at any time of the year: but trees that are subject to "bleeding," like the cedars, pines, spruces and firs, should be pruned, if possible, in November and December.

Branches and brushwood should be collected and deposited in accordance with the wishes of the owner; but if matters are left in the hands of the Post Office, the cuttings should be disposed of as may be found most convenient, on the understanding that they are not left lying on the highway or in a field or garden. Special care should be taken in the disposal of cuttings from poisonous trees, such as yew, laburnum, and rhododendron, which are deadly to cattle.

Unless these rules are carefully observed, substantial payments in compensation may have to be made, the Postmaster-General's relations with landowner's and others may become

seriously strained, and the difficulty of obtaining or securing wayleaves greatly increased.

Whether in a particular instance the necessary pruning can be most neatly and efficiently done by the pruning rod equipment, or by the use of ladder, hand-saw, and hand-clippers, or by a combination of both, is a matter for a lineman's private judgment.

It is undesirable, on account of the possible interruption to circuits, to cut heavy branches near working wires between 10.0 a.m. and 4.0 p.m., and in any case, a branch which in falling might foul the wires must be roped before being cut.

4.—SAFETY BELTS.

The Engineering Department has devoted much care to the design of the present thoroughly efficient safety belt, and if it

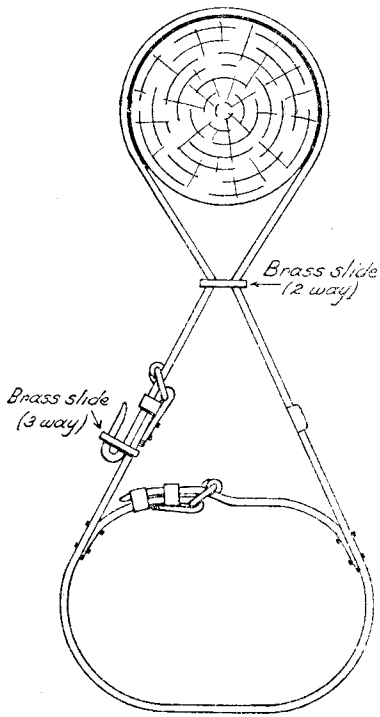

Fig. 10.

is kept in good condition by reasonable care and used on all appropriate occasions, such accidents as the belt is designed to eliminate will not occur.

Fig. 10 clearly shows the component parts of the belt, including the two-way and three-way brass slides in correct position. The three-way slide is a recent addition and gives great security when working among the wires on the outside of long arms.

It is intended that safety belts should be used on all occasions when not working from ladders.

Should a belt come into contact with acid, whether through some carelessness or by accident, it is important that it should be specially examined, for hidden defects may have been caused which may become evident only when the belt breaks, causing an accident.

A wall bracket, insulator spike, pole finial or other fixture or structure which is itself liable to give way—for example a window frame or an old chimney—should never be used for attachment.

5.—POLE DIAGRAM BOOKS.

Pole diagrams, which are now prepared in leaflet form and enclosed in a loose-leaf cover, constitute a very essential record without which the lineman maintaining a route of through wires has no ready means of determining what the individual circuits are. The particulars are entered on specially printed forms: Form TE 457 is used for ordinary 4-way arms, and for the 6-way arms on "H" poles; and Form TE 507 is used for 8-way arms.

A correct pole diagram represents the conditions as the pole is viewed by an observer with his back to London, in the case of main lines, or to the UP-station, in the case of a local line. Two typical pole diagrams are illustrated in Figs. 11 and 12.

The weight of conductor is indicated in black ink for iron and red for copper, 40 lb. and 70 lb. cadmium copper and bronze. The letters C.C. are added after the weight where the conductor is cadmium copper.

Inaccuracy in a pole diagram is generally very early brought home to the lineman maintaining the relevant route. The detailed examination of 10 miles or so of route in bad weather after a fault, closely scanning the wrong pairs of wires all the time, is an experience which fixes itself securely in the memory. A lineman, especially one on relief duty, has a right to expect that the pole diagram records handed to him should be absolutely correct.

6.—PRECAUTIONS.

In connexion with a lineman's duties, it is very necessary that strict precautions should be taken to prevent accidents of any kind, and with this end in view, workmen should become well acquainted with the information given in **R.G. 41 Precautions Against Accidents,** a copy of which is issued to each workman.

Route	Section	Pole
LE-NKH (TRUNK.)	From NORTH KILWORTH. To FOSTON LANE END. Length.....m..... yds.	No. 1 No. 243

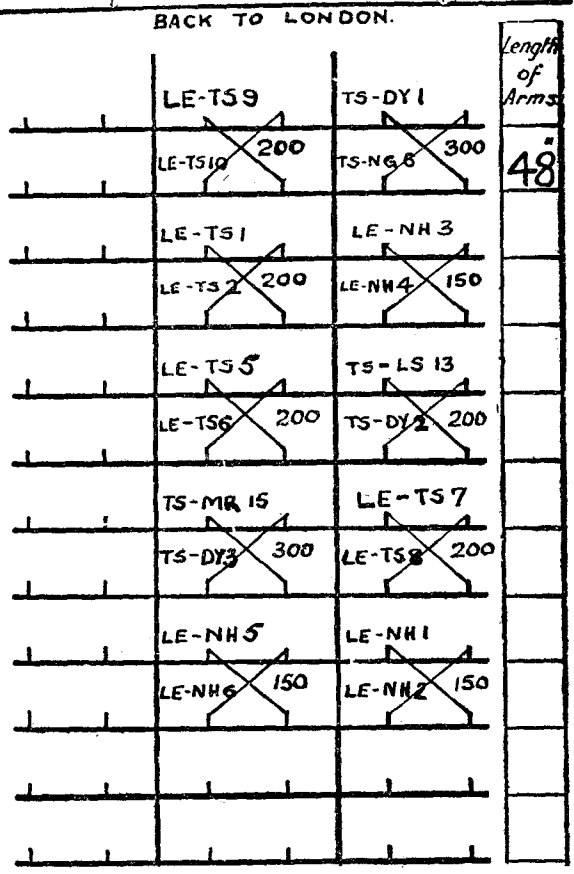

Fig. 11.

Route	Section	Pole
LO-DY ROAD	From Jc. OFFILERS	No. 98
	To Jc. WILNE	No. 113
	Length.....m..... yds.	

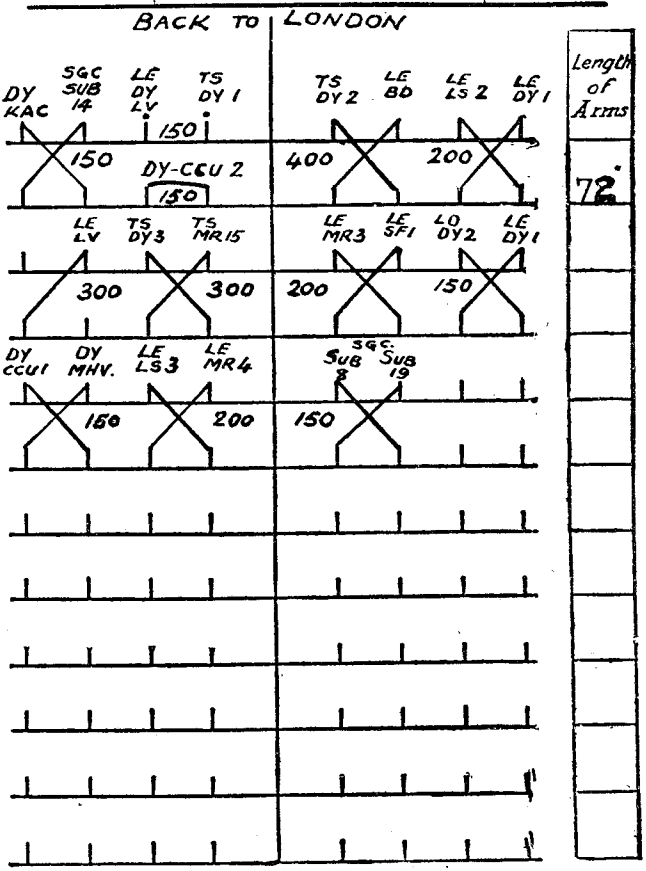

Fig. 12.

(27343) Wt. 873/263/321 2,125 9/35 Hw. G.344 (TS.8)

LIST OF
Technical Pamphlets for Workmen
(Continued)

GROUP D—*continued*

19. Cord Repairs.
20. Superposed Circuits. Transformers. Bridging Coils and Retardation Coils.
21. Call Offices.
22. Units, Amplifying. (*Not on Sale.*)

GROUP E

1. Automatic Telephony. Step-by-Step Systems.
2. Automatic Telephony. Coder Call Indicator (C.C.I.) Working.
3. Automatic Telephony. Keysending "B" Positions.

GROUP F

1. Subscribers' Apparatus. Common Battery System.
2. Subscribers' Apparatus, C.B.S., Part I—C.B.S. No. 1 System.
3. Subscribers' Apparatus. Magneto.
4. Private Branch Exchanges—Common Battery System.
5. Private Branch Exchange—C.B. Multiple No. 9.
6. Private Branch Exchanges—Magneto.
7. House Telephone Systems.
8. Wiring of Subscribers' Premises.

GROUP G

1. Maintenance of Secondary Cells.
2. Power Plant for Telegraph and Telephone Purposes.
3. Maintenance of Power Plant for Telegraph and Telephone Purposes.
4. Telegraph Battery Power Distribution Boards.

GROUP H

1. Open Line Construction, Part I.
2. Open Line Construction, Part II.
3. Open Line Maintenance.
4. Underground Construction, Part I—Conduits.
5. Underground Construction, Part II—Cables.
6. Underground Maintenance.
7. Cable Balancing.
8. Power Circuit Guarding.
9. Electrolytic Action on Cable Sheaths, etc.
10. Constants of Conductors used for Telegraph and Telephone Purposes.

GROUP I

1. Submarine Cables.

GROUP K

1. Electric Lighting.
2. Lifts.
3. Heating Systems.
4. Pneumatic Tube Systems.
5. Gas and Petrol Engines.