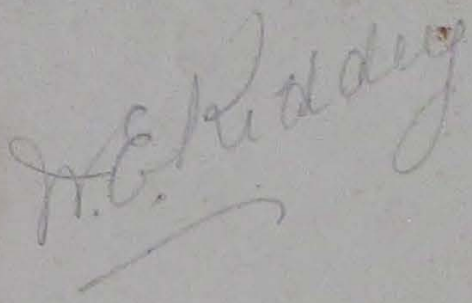
HANDBOOK

FOR

ROYAL ENGINEER VOLUNTEERS.

1909.



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CHAPTER I.

DISCIPLINE AND DUTIES.

DUTIES OF OFFICERS AND N.C.O.s.

DUTIES OF OFFICERS COMMANDING ENGINEER COMPANIES.

1. THE O.C. Company is responsible for its training, discipline, and interior economy in every particular.

2. He is responsible that the kits, uniforms, arms, and accountrements of his command are complete and in good order.

3. Great care is to be observed by the Company Commanding Officer to maintain at all times the system by which each subaltern officer should have and exercise full responsibility for the charge of his own section. The Commanding Officer should emphasize the importance of this system by working through the subalterns of sections, and not through the company sergeant-major.

4. On taking over the command, he is to satisfy himself that—

(*a.*) All books are written up to date, and produced ;
(*b.*) All stores on charge to officer handing over are mustered and checked by officer taking over ;
(*c.*) All deficiencies or excesses are brought to account and adjusted ;
(*d.*) All cash-books and accounts are signed by both parties as correct, &c.

5. He is to instruct the officers of his company in their duties.

6. Company Commanders are to frequently inspect the squad-books of their subaltern officers, and ascertain that they are kept up to the latest date.

7. An O.C. Company is responsible that N.C.O.s and men are trained to take up the duties of the instructors and specialists.

8. The O.C. Company is responsible for all stores on issue to his company, and it is his duty to inspect the same frequently, and to hold the individuals in whose immediate charge they have been placed responsible for them.

9. He is to be most particular in having correct records kept of the drills carried out by each man.

Duties of Subaltern Officers.

1. Subaltern officers are required to have an accurate knowledge of the company to which they belong, and a close attention to duties is expected from them.

2. They are responsible for everything connected with their sections.

3. They are to keep a squad-book, which should be carefully revised up to date, containing a nominal roll of the men and all information they require regarding their sections.

4. Passes must be initialled by the man's sectional officer before being submitted to the O.C.

5. Officers will frequently visit the barrack-rooms and tents of their own sections when in camp. They are respon-

sible to the Commanding Officer of the company for the general appearance and cleanliness of rooms and tents.

6. At weekly parades when the "Fall in" sounds they will attend the parade, and after the roll has been called will inspect their own sections. They will insist on the utmost steadiness and smartness when on parade.

7. They will always be present with their sections, although a Staff instructor may be employed giving instruction.

Duties of N.C.O.s.

Company Sergeant-major.

1. As the senior N.C.O. of the company and the assistant to the O.C., he must be an example of activity and soldier-like conduct.

2. His position is one of great responsibility, but it depends upon his own assiduity and tact whether he receives the attention and respect to which his rank entitles him.

3. He must exact prompt obedience to his orders, and instantly correct any want of energy or smartness he may observe. He should make himself acquainted with every N.C.O.s ability, and bring any irregularity among the N.C.O.s at once to the notice of the O.C. He is responsible for the orders of the day being correctly copied. He is the channel through which all orders to N.C.O.s are conveyed. He will see that men's clothing and badges are correctly worn.

4. He should be master of everything relating to drills. He is to keep a duty-roster, detail all duties, and give out the orders. He will detail an orderly sergeant and orderly corporal for duty each month, and for each day when in camp. At the weekly drills he will see that the orderly sergeant performs his duty in a proper manner. He will fall in all parades punctually, and after receiving reports from the N.C.O.s in charge of sections he will report to the inspecting officer (O.C. or officer on duty) and accompany the latter round the ranks during the inspection.

He takes charge of all orders & circulars

5. During the drills he will generally assist the O.C. by visiting the various squads and seeing that the men are attentive and smart at their drill.

6. He will assemble the company prior to dismissal, read the orders, warn N.C.O.s or men for duty or special parades. He will see that every N.C.O. and man is fully employed at the weekly drills. He will detail the detachments for their respective duties.

7. He will be responsible for the training of recruits, and will visit the recruit squad from time to time, check the attendance-roll book, question the men on their duties, and report when they are ready for passing into the ranks.

8. Minor misunderstandings or difficulties arising among the N.C.O.s should be adjusted where possible by him. Matters of a serious nature should be referred to the O.C.

Company Quartermaster-sergeant.

1. He has charge of, and is responsible to the O.C. for, the equipment, clothing, and stores of all kinds. He has charge of all orders and circulars and other books supplied to the company.

2. The clothing and kits issued to N.C.O.s and men should be properly marked before delivery, showing height, chest, waist, and number.

He is responsible to the O.C. that the arms, accoutrements, and clothing of any man becoming non-effective are returned into store. If the articles are not returned within a week after the date of becoming non-effective, he is to warn the individual concerned, personally or by letter, that the articles must be returned forthwith. If such articles are not returned within twenty-one days he is to make a special report to the O.C.

3. His books are to be ready at all times for inspection. and the clothing-ledger should show at sight what clothing is on charge, what articles are in store and on issue.

4. Every six months the whole of the clothing is to be inspected, and damaged clothing repaired or destroyed.

5. All clothing on charge is to be disinfected with camphor, and all arms covered with mineral jelly.

6. He will accompany the O.C. at his half-yearly muster parade to note repairs to uniforms, &c., that the O.C. may order to be carried out.

Sergeants in Charge of Sections.

1. The position of sergeant of Field Engineers is one of such importance as to require great intelligence for the proper discharge of his duties; he must therefore have a sound practical knowledge of his duties on parade, and be capable of instructing in all the subjects required of him.

2. He is required to set an example of discipline, smartness, and efficiency at all times, and he must insist upon a high standard of efficiency and discipline being maintained by the men of his detachment.

A sergeant will always refer to the authority of the C.S.M. and promptly execute all orders or directions received from or through him. The sergeant in his turn will exact the same attention from his juniors, and support his junior N.C.O.s in the proper exercise of thier authority. He will keep a roll-book containing names of men of his section, with their addresses and complete military record.

3. He should not only procure each man's private address but also the quickest way of communicating with him in case of mobilisation or special parade.

4. He is to be most regular in his attendance at drill, and he must never be absent from any parade or meeting without arranging for the next senior N.C.O. to act as a substitute for him.

5. If unable to attend at parade he should communicate with the subaltern in charge of his unit, and obtain the necessary leave.

6. He is to be on parade five minutes before the appointed time, in order that when the "Fall in" sounds he can call the roll, inspect his men, and report without delay.

7. When inspecting his detachment every detail regarding cleanliness of clothing, boots, &c., is to be noted, and irregularities reported.

8. He is responsible for the discipline of his detachment at all times. When on parade he is to check the slightest inattention or irregularity on the part of his men, such as unsteadiness or talking in the ranks when "Stand easy" has not been given, slovenly drill, &c.

9. At the conclusion of every parade he will personally warn his men for any parades during the following week, and ascertain if any leave is required.

10. If a man is absent from two consecutive parades, the cause is to be ascertained, and a report made to the subaltern in charge of his section.

11. He is to instruct his junior N.C.O.s in their duties, and must not allow familiarity on the part of the men while on parade.

12. When a man's clothing is damaged or worn out he will take immediate steps to have the matter attended to.

13. On the first weekly parade of every month he will hand in a report showing the names of all N.C.O.s and men of his section, the parades they have attended during the month, and any remarks he may wish to bring to the notice of his officer.

Rank and File N.C.O.s.

1. They are to support and assist their sergeants in every possible manner.

2. When the sergeant is absent the next senior will take his place. They are therefore required to be competent to command a detachment, and smart in their manner.

3. N.C.O.s must allow no familiarity on the part of the men when on parade, and must exact prompt obedience to their orders.

4. They will check all unsteadiness in the ranks and irregularities, and strive to maintain a high standard of discipline in the company.

5. They should work harmoniously with their sergeants, and see that their juniors carry out all orders and directions received from or through them.

N.C.O.s and Sappers.

While on parade silence, steadiness, and obedience are required.

Punctuality is most important. Any N.C.O. or sapper coming late to parade must fall in rear until ordered to join the ranks by the officer on duty.

When in the ranks do not reply to an officer or N.C.O. when found fault with. When asked a question, reply in a respectful manner.

Submit to discipline, and carry out all orders given by superiors.

If you wish to complain to an officer you must first inform your section N.C.O., who will take you to his subaltern.

No N.C.O. or sapper must address an officer in writing without sending it through the sergeant-major; and when present with the company a N.C.O. or man should not address his officer in writing. If a man wishes to address an officer he must always be accompanied by a N.C.O.

N.C.O.s will always treat their subordinates with respect. They will also always remember that they have to set an example in all things—smartness, cleanliness, discipline, efficiency, &c. They must render every assistance to their officers, and on no account discuss with the men the efficiency of their officers, or allow the men to criticize them.

N.C.O.s are at all times to avoid using intemperate language or being offensive in their manner.

N.C.O.s will be held responsible for their sections, and they will be most particular *re* cleanliness of arms, accoutrements, clothing, &c.

They will check all irregularities.

When a man does anything wrong a N.C.O. should always correct him, as it is probable that the man acted in ignorance, and when once checked for an offence he will not be likely to repeat it.

A N.C.O. in charge of a section should try to make it the best in the company, the first on parade, smartest at drill, most attentive to duty, the cleanest in the camp, &c.

N.C.O.s are to prevent noise after "Lights out," or disturbances in camp.

No man is ever to leave the precincts of a camp without being properly dressed.

If a N.C.O. is confined for drunkenness the officer or N.C.O. confining him will immediately send for the two senior N.C.O.s of the company to appear as evidence.

A N.C.O. confining a man for drunkenness must always obtain the opinion of another N.C.O. or sergeant of guard, who should appear as evidence.

Testing a man to see if he is drunk is strictly prohibited.

A soldier should be ashamed to make a trivial complaint; but, at the same time, he should never be afraid of reporting any real grievance, which his officers will be sure to fully consider.

No boating party is ever to go out except with a N.C.O. in charge.

Writing to the Press without authority *re* military matters is prohibited.

A sapper placed temporarily in charge of a squad is for the time being the superior officer, and has to be obeyed as such.

Ignorance of published orders is no excuse for their non-observance.

POLITICAL MEETINGS.

Soldiers, individually or collectively, must not attend political meetings, processions, or demonstrations.

HAIR AND BEARD.

Hair must be neatly cut, and very short. Moustaches should be worn, and whiskers, when worn, are to be of moderate length.

ESPRIT DE CORPS.

1. All soldiers should cheerfully submit to discipline, and consider the welfare of their corps in all things.

2. On parade be as smart and keen as possible, off parade be a credit to their corps.

3. By the practice of self-denial and submission to discipline, being thorough in all things connected with their duty, by considering the welfare of the corps in preference to their own personal feelings, they will assist to raise the efficiency of their corps to a very high standard.

SALUTING.

Never salute in a slovenly manner. Bring the hand up smartly, and cut away smartly on completion of the salute.

When passing an officer salute on the third pace before reaching him, and do not lower the hand until the third pace after passing him.

If sitting when an officer approaches, rise, stand at attention, and salute with right hand.

If standing, come to attention, and salute with right hand.

If a group of soldiers are standing together and an officer approaches, the senior will call the men to attention and he himself will salute while the officer is passing.

When addressing an officer, halt two paces from him, salute with right hand, and salute again when withdrawing.

If before an officer in a room, salute without removing cap.

If without a cap, or otherwise improperly dressed, or carrying anything that prevents a man saluting, he will, if standing still, come to " Attention " as the officer passes ; if walking, he will turn his head slightly towards the officer in passing him.

When Volunteers in uniform are passing a regiment they salute the O.C.

If the colours are uncased they will salute them also, and stand to attention while the regiment passes.

Officers or N.C.O.s in charge of armed parties, and passing officers, guards, or armed parties, give " Eyes right " (or " left "), the party marching at the slope, and the officer or N.C.O. saluting the guard or officer.

In passing funerals the corpse is saluted by individuals in the same way as for saluting officers. With military funerals individual soldiers will halt, turn inwards, and salute the corpse.

When an armed party meets a military funeral, the party is halted and fronted at the slope, " Present arms " being given as the corpse passes.

In a civil Court a soldier removes his head-dress while the Judge or Magistrate is present, except he be on escort duty.

Warrant officers are addressed in the same manner as officers, but they are not to be saluted.

If a soldier with arms is halted when an officer passes he will turn towards him and stand at the order.

When a Volunteer with arms passes an officer he will do so at the slope, and will salute by carrying the right hand smartly to the small of the butt, fore arm horizontal, back of the hand to the front, fingers extended, saluting on the third pace before reaching the officer, and cutting the hand away on the third pace after passing him.

A man who wishes to speak to his officer comes up with his rifle at the slope, halts two paces from him, and then salutes as in previous paragraph, saluting again before withdrawing.

When in command of an unarmed party he will fall in, salute with the right hand as he gives the command "Eyes right" or "left."

When armed with long swords a salute is always given with the right hand, irrespective of the side on which the officer saluting may be passing.

When boarding a man-of-war a soldier always salutes the quarter-deck.

When the National Anthem is played a soldier salutes without removing his head-dress. The salute should last for eight bars.

When two or more are passing an officer they salute, taking the time from the man nearer to the officer, bringing the hands up and lowering them smartly together.

An officer with sword drawn never returns a salute.

Officers without arms salute in the same way as laid down for N.C.O.s and men.

N.C.O.s and men should be very particular *re* saluting, as neglect of this duty reflects on the corps to which they belong. They should remember that they are not saluting the individual, but the King's Commission. Salutes to officers are always properly returned.

They should be most careful in saluting officers of other branches of the service, as omission to do so is not only an obvious neglect of military duty, but displays a lack of courtesy which each branch of the service of the Dominion should show to the other.

PRISONERS.

All cases of confining men mentioned below refer to camp-discipline. Offences committed at the ordinary weekly drills are immediately reported by a N.C.O. to the sergeant-major. A N.C.O. will never confine a man in the guard-tent, excepting for violence, insubordination, or drunkenness. For any other offence he is made a "prisoner at large," when he will

be merely confined to camp. In both instances the N.C.O. will make out a crime, get witnesses, and report to the sergeant-major.

If a N.C.O. commits a serious offence he is placed in "close arrest" under another N.C.O. If the offence does not warrant confinement he is placed in "open arrest"—*i.e.*, merely confined to camp.

When a man refuses to obey an order he is to be at once confined in the guard-tent.

In confining a man the N.C.O. gets two sappers to assist, while he himself avoids personal contact.

"Prisoners at large" do not wear arms; they attend parades, but are not detailed for duty, &c.

When a prisoner is taken before his officer an escort is detailed to march on his right, the witnesses on his left; he is deprived of cap and belt while the charge is investigated.

As each witness's name is called he states his evidence.

The escort for a N.C.O. must be of equal rank.

When a prisoner is taken to a guard-tent, the N.C.O. removes all knives, pipe, tobacco, &c., from his possession, and takes a careful inventory of the same.

A N.C.O. confining a man always makes out a crime, and hands to commander of guard, and also reports the matter fully to the sergeant-major.

A man once confined cannot be released except by order of O.C.

PARADE.

When the bugle sounds, fall in smartly, and stand at ease.

When the "Fall in" sounds, every man should double on to his marker. Walking up leisurely to fall in after the bugle sounds is an indication of slack discipline.

When name is called, spring to "Attention," answer "Here" in an ordinary tone of voice; if an officer is present, answer "Here, Sir," afterwards "Standing at ease."

Remember the difference between "Stand at ease" and "Stand easy."

When at "Attention" or "Stand at ease" keep head and eyes steady, look straight to the front. N.C.O.s in supernumerary rank will check unsteadiness in the ranks.

Talking in the ranks or unsteadiness when men are supposed to be standing properly at ease is the most conspicuous indication of bad discipline.

N.C.O.s in charge of parties will, prior to dismissal, ask permission to dismiss them from any officer who may be present at the time.

If an order is given from the position of "Stand at ease" spring smartly to attention, and perform the movement without waiting to be called to "Attention."

Nothing looks so bad as to see men talking or looking about when marching at attention.

The following points make a corps conspicuous for smartness if carried out when marching :—

Heads erect.
Eyes straight to front.
Short, quick, and swinging pace.
Rifles all at same angle.
Sections of fours well dressed.

DRESS.

Never appear in uniform unless properly dressed. A mixture of uniform and mufti is strictly prohibited.

Mufflers must not be worn in uniform.

Always assume an attitude of smartness, whether in or out of uniform. Hold the body and head erect, and acquire an easy but not slouching habit.

When two are walking together, keep in step ; if with arms, carry your rifles in the same position.

Never appear in public streets with untidy uniforms.

CLEANING ARMS AND ACCOUTREMENTS, ETC.

NOTE.—As each man is responsible for the care of arms, clothing, &c., on issue to him, the following instructions are for his guidance.

CLOTHING.

After every parade, and before putting the uniform away (if not wet), give it a good brushing and fold neatly. If wet, let it be thoroughly dried before being brushed.

Always have white clothing clean and ready to turn out at the shortest notice—lanyards washed, and grease-spots removed from clothing with ammonia or turpentine.

To clean Gold Lace, &c.

Take $\frac{1}{8}$ oz. of cyanide of potassium, and dissolve in half a cupful of water. Lightly sponge over the gold lace with this mixture, afterwards sponging with clean water.

ACCOUTREMENTS.

Brown Leather.

It is most important that all brown-leather accoutrements should be cleaned in the same way, in order to secure uniformity of shade.

When the belts are dirty, wash them with good common soap and water, using a sponge for the purpose; after which rub them as dry as possible with either chamois leather or a towel, and hang them up. When thoroughly dry, clean the metal mountings as described hereafter, and polish the leather with tan-coloured harness-paste or boot-polish.

Steel Mountings.

The bayonet and steel mountings of scabbards should be cleaned with oil and emery-powder or Bath brick and a piece of rag or old woollen material. Oil steelwork after every parade.

Brass Mountings.

Brass mountings to be cleaned with plate-powder or brilliantshine, rubbed on with a rag or old tooth-brush, and cleaned off with a brush or chamois leather.

Arms.

Care of Rifle.

It is a serious crime to have a dirty rifle. Whatever else is neglected, the rifle and bayonet must be kept scrupulously clean and well oiled.

Water must never be used for cleaning the rifle.

The use of sandpaper or emery is prohibited.

The rifle must be wiped out before every parade and kept well oiled, and with vaseline in the bore after use. The stock is to be oiled, and beeswax applied between stock and barrel.

Cork, rags, or muzzle-stoppers are not to be carried in the barrel.

Never attempt to take breech to pieces.

Never carry weights on the rifle-barrel.

Salad and kerosene oil must not be used on a rifle, as they remove browning.

Mineral jelly or vaseline is used for the inside of barrels, and vaseline or Rangoon oil for the outside.

Immediately after firing, the bore should be cleaned by the "pull-through" and rag smeared with vaseline.

On conclusion of practice it should be thoroughly cleaned as explained below; and every day for at least a week after the practice a clean rag should be pulled through the bore and fresh mineral jelly used.

Never allow the mechanism to remain cocked after use, as the spring becomes weak.

To clean the Bore.

Open the breech, oil the gauze of the "pull-through" well with mineral jelly, drop the weight through the bore from the breech, and pull the gauze completely through. Then insert in the loop nearest the gauze a piece of dry flannelette, 4 in. by 1½ in., and draw it through the bore as before; the flannelette should never be pulled back when partly through, as it would probably jam. It may be necessary to use three or

four pieces of flannelette before the barrel is *rag clean—i.e.*, before the material remains unsoiled after use, but those which are little soiled should be saved for future use. Finally, a piece of flannelette covered with mineral jelly should be drawn through, and the bore left oily. When the gauze of the pull-through, in consequence of frequent use, ceases to fit the barrel tightly, narrow strips of flannelette or paper may be inserted under each side to increase its diameter. No larger piece of flannelette than 4 in. by 1½ in. should ever be used, and it may sometimes be reduced in *width* with advantage. It saves time if two men assist one another, one holding the rifle and the other manipulating the pull-through.

To clean the Outside and Frictional Parts.

Wipe the inside of the body with an oiled rag to prevent rust and remove dirt, then clean the outside of the barrel, and oil all frictional parts of the body. To prevent water soaking into the stock, and at the same time to give it a polished appearance, it should be well rubbed with oil. French-polish or varnish is on no account to be used. Before using the rifle all dust and sand must be removed, and the frictional parts of the breech-action and the bore should be slightly oiled. The chamber and the outside of the rifle should be wiped quite free from oil.

Unless proper care is taken with the rifle as explained above, it will soon get out of order, and is liable to be condemned, and a charge made against the corps for a new barrel, &c.; whereas, when proper care is taken, a rifle has been known to fire 20,000 rounds, and not be in the least damaged.

MOBILISATION.

The mobilisation scheme is always confidential; the following, however, is for general information.

Field Kit.

On being warned to "Parade for service" all ranks hurry

by the nearest route to place named, each N.C.O. and man having—

Dress.—As for "marching order," with strong piece of cord, matches, pipe, tobacco (for smokers), haversacks—to be filled before leaving home with sufficient cooked meat and bread, &c., for two meals—knife, fork, spoon, tin plate, pannikin, razor, shaving-brush, towel, soap, clothes-brush, hair-brush, and comb.

Baggage.—Waterproof sheet, two blankets, change of shirt and underclothes, pair socks, cleaning-material for arms; needles, pins, and thread; dubbing and brush for boots, pair of old trousers or overalls, and small necessaries; also a pair of canvas shoes for use in camp. To be tightly rolled and strapped, and distinctly labelled.

As men and baggage arrive, their names should be entered on a roll, and sentries posted over the baggage till packed on the baggage van or steamer.

Officers' Service Kit.

In addition to that carried by men, officers and N.C.O.s will also have—1 watch, whistle, field-glass, 1 pair overalls, 1 pair strong boots, 1 spare patrol jacket and cap, 1 extra towel, 1 writing-portfolio, pens, ink, and paper, 1 journal-book, 1 linen bandage, 1 pocket-book for field-sketching, and useful sundries.

Provisions.

The following will serve as a guide in requisitioning for supplies when in the field: 1¼ lb. bread or biscuit, 1½ lb. fresh or preserved beef, 2 oz. cheese, ½ oz. coffee, ¾ oz. tea, 3 oz. sugar, ½ oz. salt, $\frac{1}{32}$ oz. pepper, 1 lb. potatoes, ¼ lb. jam, 1 candle per tent per day, 72 lb. straw per tent, 2 lb. wood or 1 lb. coal.

NOTES ON CAMPS.

On receipt of order to mobilise for either continuous training or instruction camp the unit will assemble at the appointed

rendezvous in service-dress marching order—haversack to contain one day's rations, knife, fork, spoon, razor, clasp-knife, pannikin, plate, &c.

Kit-bags to be plainly addressed with each man's name and corps, and to contain two blankets, waterproof sheet, spare laces, towel, soap, shirt, socks, comb, &c.

If possible, each section will place its bundles into one large bag, and should arrange to have a set of blacking-brushes, blacking, looking-glass, clothes-brush, oil, and cleaning materials for each tent.

Movements by Rail.

ENTRAINING.

An officer and N.C.O. is sent to the station in advance of the company, and on receiving the necessary information from the Stationmaster they proceed to mark with chalk on the carriages the name of the corps to which they are allotted. The officer then posts the N.C.O. as marker for the company to march on on arrival.

The company should arrive at the station twenty minutes before the time named for the departure of the train, and be halted at a convenient spot outside the station, and be told off in sections corresponding to the size of the compartments, the details of which will be given to the O.C. by the officer who has preceded the party for that purpose. The company will then move on to the platform in fours. When the rear of the company arrives at its marker (previously posted) it will be ordered to halt and turn towards the train, still remaining in fours, closing in if necessary. The O.C. will move along the front of his company, and point out to each section the compartment it has to occupy. He will then fall out the N.C.O.s, detail one to take charge of each compartment, and give any necessary instructions. The men entrain by word of command, and in silence and order. The Q.M.S. and a party of men will entrain the baggage previous to arrival of company, and report when work is completed.

1. *Entering Carriages.*

The seats will be filled from the furthest end in succession, the men storing away their coats, &c., afterwards taking their seats ; rifles on no account to be laid on the floor under the seat.

2. *Conduct.*

Just before the train starts " Fall in " is sounded, and men must maintain silence, and no man is to leave the carriage without permission, except when ordered by his officer or requested to do so by the railway officials.

3. *Rules to be observed at Halting-places.*

Blowing bugles or trumpets, making unnecessary noise, or getting out of carriages, is strictly prohibited.

Two men per carriage are to act as sentries : they are posted by the N.C.O., and are to prevent men getting out without orders, getting out the wrong side, or straggling.

Officers will at all halting-places get out, and go to the carriages of their men.

When permission is given for the men to leave the carriages " Dismiss " will be sounded, and those who require to do so will get out of their train, leaving their arms in the carriages.

At " Fall in " the men will at once return to the carriages. N.C.O.s will report to the officer " All present," and the latter will report to the O.C. ; the sentries will then be withdrawn, and the officer gets in, and instructions are given for the train to proceed.

4. *Action in Case of Accident.*

Officers go straight to the men's carriages, and see that they keep their seats until ordered to descend. Directions given by railway officials must be promptly executed.

5. *Detraining.*

On arrival at destination the men wait for the order to detrain. Officers go straight to the men's carriages, and

before they get out give orders as to the spot where they are to form up.

On the order to detrain being given, the men get out, rifle in hand, and properly equipped; and if falling in on the platform do so in exactly the same manner as before entraining—*i.e.*, in fours, facing the carriages.

Notes.—The Q.M.S. will always look after baggage, see that it is kept separate on detraining, and brought to camp as quickly as possible. He sees that the van containing baggage is not shunted off by the railway authorities without notice. When two companies have their baggage in the same van he will see that a division is kept.

On arrival in camp a nominal roll of the company and a "Marching-in State" is handed to the Adjutant, who will conduct the company to its lines, after which the men will be told off to their tents and dismissed, fatigue-parties, guards, and pickets being detailed as required. Before dismissal the men are informed of the position of the latrines, water-supply, and the alarm-post.

Instructions for N.C.O.s and Men.

1. Clean arms and accoutrements directly you come in off parade. Use plenty of oil for arms in camp.
2. Keep your tent tidy and neat.
3. Always keep tent-buckets with water for use, and in case of fire. (Tent orderly is held responsible for this.)
4. Fold up your clothing and kit, and roll up in waterproof sheet during the day.
5. Be careful of Government stores, as your corps is called upon to pay for deficiencies. See that tent-valise, peg-bag, mallets, and spare pegs are neatly arranged on the left-hand side of the doorway, inside the tent, and cooking-utensils, &c., on the right, clean and ready for inspection, before you go on parade.
6. Always have a suit of old clothes for dirty work.

7. The proper camp latrines must always be used.

8. Always turn out clean and smart, clothing well brushed, boots clean, arms and accoutrements in perfect order. Shave every morning before 9 o'clock parade.

9. When on parade, particularly with other corps, look as smart as possible, keep perfectly steady in the ranks, and try to make your corps the best in the camp.

10. Be careful about language. N.C.O.s are responsible that bad language is not used in their tents, that the lights are put out when the bugle sounds, and no noise allowed in the tent after "Lights out."

11. Make it a point to be thoroughly acquainted with all orders. N.C.O.s of tents should see that their men know the orders for the next day as early as possible.

12. Never walk through the officers' lines of tents.

13. Always appear properly dressed outside your own lines.

14. Remember that by a breach of the regulations, or by misconduct, you bring discredit on yourself, your corps, and your officers.

15. When on leave let your dealings with civilians be such that they will respect you.

16. Be very particular about saluting all officers, and always salute in a smart manner.

17. N.C.O.s must always use the N.C.O.s canteen, and not drink at the general canteen.

18. Sergeants always mess in the sergeant's mess.

19. N.C.O.s and men returning to camp after "tattoo roll-call" have to report themselves to the commander of the guard, after which they go quietly to their tents.

20. Never enter camp after "tattoo roll-call" excepting by the proper entrance—*i.e.* by the main guard.

Camp Duties.

At divisional camps captains of companies are detailed in turn for captain of the day.

Subalterns are also detailed in turn as camp or regimental orderly officer.

Sergeants take their turn as regimental orderly sergeants.

In addition to above, companies should each have an orderly officer, orderly sergeant, and orderly corporal, to carry out discipline and duties in connection with the corps.

Captain of the Day.

His term of duty is from reveille until reveille next morning.

He wears his sword when on duty.

He is responsible for the discipline of the camp, and is assisted by the orderly officer, regimental orderly sergeant-major, orderly sergeant, orderly corporal, orderly trumpeter, guards, and sentries.

He attends all parades.

Assisted by the quartermaster, he superintends cleanliness of camp.

He attends parades of regimental guards, visits them once by day and once by night. When visiting sentries he is always accompanied by the commander of the guard.

He is not allowed to leave the camp.

He instructs subalterns of the day when to visit the guard; inspects rations before issue, and sees that issue is properly carried out; visits tents at breakfast and dinner to see that provisions are of good quality, and well cooked. He will be assisted by the orderly officer, who will also visit a portion of the tents. (If company orderly officers have been round the tents of their companies, it is unnecessary for the captain of the day or regimental orderly officer to do more than walk down the lines and receive reports from them.)

Accompanied by the quartermaster, he inspects the whole of the camp at 10 a.m. (or as convenient).

He makes himself acquanited with all standing orders, and sees that his officers and N.C.O.s for orderly duty do the same, and that they know their duties thoroughly.

He sends in his report to the regimental orderly room (together with the reports from the orderly officer, regimental orderly sergeant, &c., to the orderly room) by 9 a.m. the following morning.

Company Orderly Officer.

In camp he is to parade and march off the regimental guard (if any). He is to visit the men confined in the guard-tent, and ask them if they have any complaints to make. He is to visit the sentries and pickets, and see that they are alert and on their post, and acquainted with their orders. He is to be present every morning at the issue of the men's rations. He is to visit the canteen daily during the hours it is open. He is to visit the camp hospital. He is to attend all parades.

He is to visit the kitchen and see that the meals are properly cooked and the messes correctly supplied. He is to visit the rooms and tents at meal-times, and see that the men are present and properly dressed, and ascertain if there are any complaints, and see that the same are remedied.

He is to read out at the morning parade such regimental or other orders of the previous day of general importance, as may be necessary.

He is responsible that all orders that may immediately concern N.C.O.s and men are properly communicated to them at the earliest opportunity.

When there is no adjutant, or when the adjutant may be absent, even for a few hours, he is *ex officio* the acting adjutant.

He will pass to O.C. units concerned casualty reports of any cases of absence, arrest, or any unusual occurrence about which they should be informed.

He is not to leave camp or barracks except on duty, nor to exchange duty unless with permission of O.C.

He receives a report from the orderly sergeant at tattoo roll-call that all the men of his company are present or accounted for.

He is to send in a daily report to the O.C. camp.

Company Orderly Sergeant.

He is detailed by the sergeant-major, and commences duty at reveille. Reports any irregularities to the orderly officer. Goes round the tents at reveille and sees all the men up. Sees the tent-flies rolled up half an hour afterwards.

When "Rations" sounds, he parades the orderlies, reports to the orderly officer, and marches them to the place where uncooked rations are served out, and reports to the regimental orderly sergeant.

At meal-times, when first bugle sounds, he falls in the orderlies, reports to the orderly officer, and marches them to the kitchen, sees the rations issued, and marches the orderlies back to their lines.

Goes to the orderly officer at reveille for orders, taking with him the order-book.

Goes round the tents with the orderly officer or any other inspecting officer, calls "Attention" at each tent, and at meal-times asks if there are any complaints.

When "Orders" sounds, he goes to headquarters and writes out the orders, afterwards giving book to sergeant-major of his company; and when company orders have been issued, he gives book to orderly corporal to show round to all officers and N.C.O.s. He calls the roll at tattoo, goes to the guard-tent, and falls in with all other company orderlies to report to camp sergeant-major "All present," or otherwise. Sees lights out when "Lights out" sounded, and reports to his company orderly officer.

He makes out his report, and hands it to the orderly officer next morning by 8.30 a.m.

CHAPTER II.

PRINCIPLES OF ELECTRIC TELEGRAPHY.

Electric telegraphy is the art of transmitting and receiving signals between two places, at any distance from each other, by means of the electric current.

In general, the material requisites for working by electric telegraphy are as follows :—

1. A continuous insulated conductor, or line.

2. A good connection to earth at each end of the line.

3. Batteries or other means of producing electro motive force at each station.

4. Keys or transmitters for sending the signals.

5. Instruments adapted for receiving the electric signals, and rendering them apparent to the sense of hearing or sight.

The above, when connected up, form the various parts of the electric circuit.

The chief points which require care and attention on the part of officers, N.C.O.s, and men of the telegraph sections are as follows :—

1. The maintenance of all material, lines, instruments, batteries, and stores in an efficient state, whether in or out of use.

2. The choice of route, position of offices, nature of line, instruments, method of working, earth-connection, and efficient supervision.

3. A thorough knowledge of the system of drill in laying out, shifting, or removing temporary lines.

4. The consideration of the best means of utilising, when practicable, the established telegraph lines and instruments of the country in which operations are being conducted.

5. The testing of all parts of an electric circuit, both ordinary, as a routine, and special, for removal of faults.

ELECTRICAL UNITS.

Ohm.—The unit by which resistance is measured. It is the resistance offered to a steady current by a uniform column of mercury 106·3 centimeters in length and 1 square millimeter in cross-section at a temperature of zero centigrade.

Board of Trade Ohm.—The resistance between two copper terminals to which a coil of platinum silver wire is attached at a temperature of 15·4 centigrade when a steady current is flowing.

Ampere.—The unit of current-strength, or by which current is measured. When a steady current passes through a solution of silver nitrate in water, and deposits silver at the rate of 0·0018 grammes per second, it is taken as the practical unit of current, and is termed 1 ampere.

Coulomb.—When the above current flows for a certain number of seconds a certain quantity of the electricity has passed. The unit of quantity is the coulomb. So we can say that when electricity flows at the rate of 1 ampere in 1 second we have 1 coulomb.

Volt.—The unit of E.M.F. or pressure. It is the pressure which, being maintained between the ends of a circuit whose resistance is 1 ohm, produces in that circuit a steady current of 1 ampere.

Mho.—The unit of conductance, and is the reverse or reciprocal of resistance. The greater the resistance the less the conductance.

CONNECTIONS FOR WHEATSTONE'S BRIDGE.

(For determining an unknown resistance.)

The connections are shown in the diagram,—

Figure II.

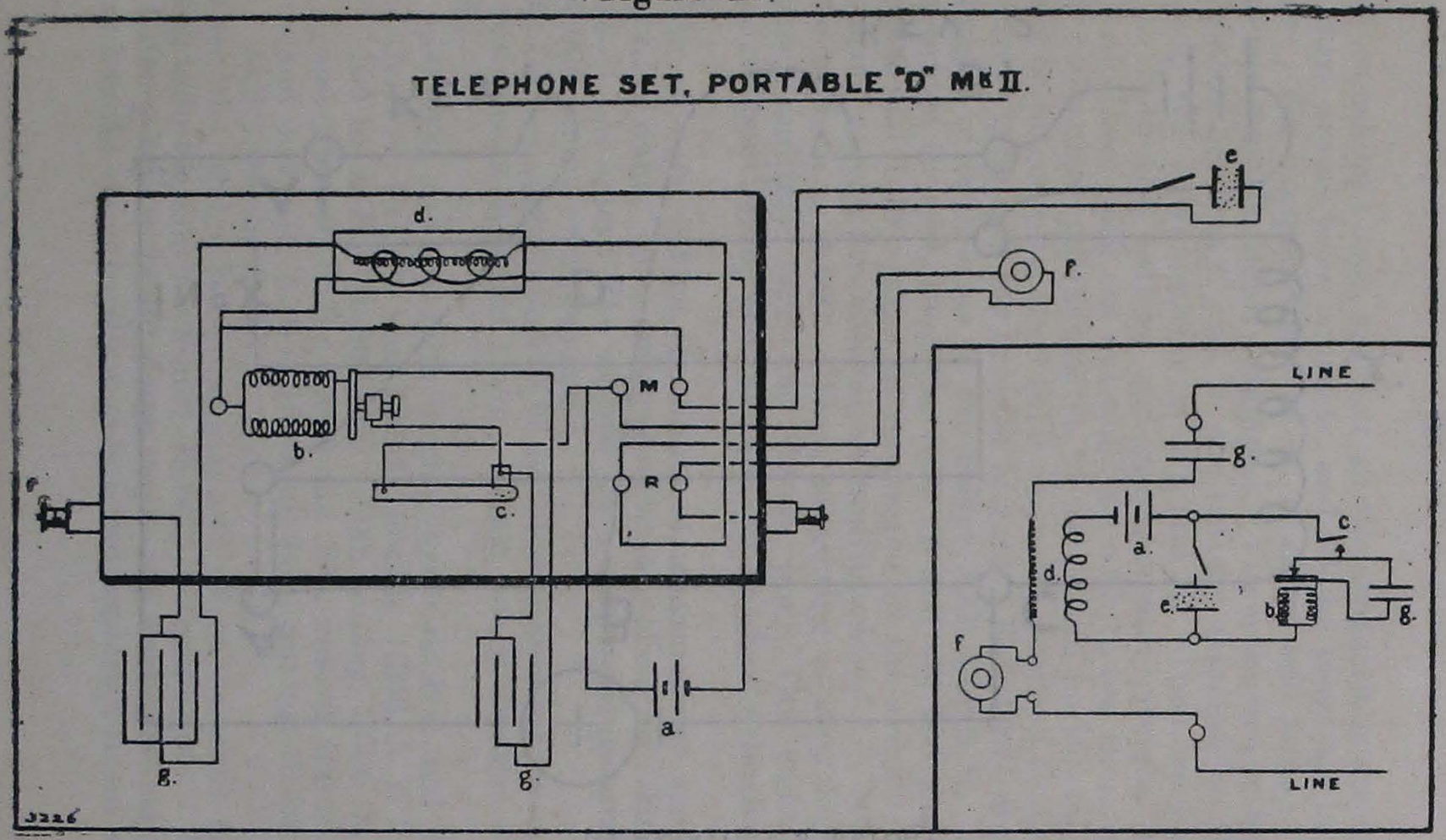
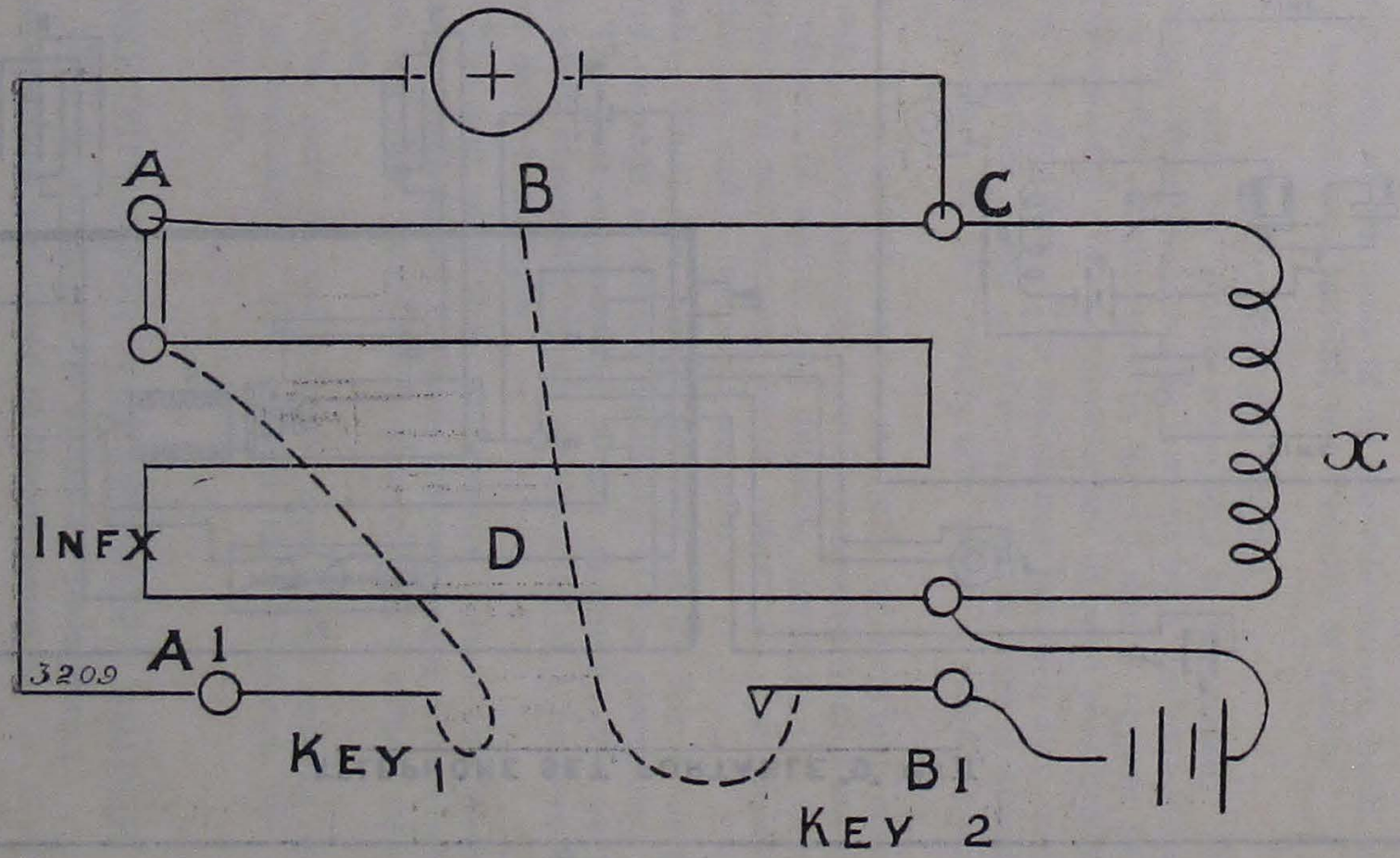


DIAGRAM SHOWING CIRCUITS OF D. MK. II FIELD TELEPHONE.

WHEATSTONE'S BRIDGE.



Before taking a test, see that all the connections are sound, and there are no loose contacts, and all the plugs are in their places. The copper strap at A is often left loose; both terminals must be tightly clamped. The unknown resistance x is placed between C and D, the battery attached to D and B1, and the galvanometer to A1 and C. Thus we have a key in both the battery and galvanometer circuits, which will keep them both cut out until we wish to use them. The most convenient galvanometer to use is the horizontal. It should be placed on a level table in such a position that when no current is flowing the index is at zero. Resistance must be unplugged in both arms of the bridge A/B and B/C. If an even bridge is used, then the coils 10 and 10, 100 and 100, or 1,000 and 1,000, must be unplugged in the arms. When measuring a very low resistance, multiply low—*i.e.*, 10—and divide high—*i.e.*, 1,000. When measuring a very high resistance, multiply high and divide low. The right-hand side is the multiplying arm, and the left-hand side the dividing arm.

With an even bridge the limits of measurement are from 1 to 11,110 ohms. The smallest resistance given by a dividing bridge is $\frac{1}{100}$ ohm; the largest by a multiplying bridge is 1,000,000 ohms, or a megohm.

The following are found to be suitable bridges for measuring the resistances opposite them. When the resistance is between—

1,000,000 and 100,000, unplug 1,000 in B C and 10 in A B; 100,000 and 10,000, unplug 1,000 in B C and 100 in A B; 10,000 and 1,000, unplug 1,000 in B C and 1,000 in A B; 1,000 and 100, unplug 100 in B C and 1,000 in A B; 100 and 0·01, unplug 10 in B C and 1,000 in A B.

When the bridge is unplugged, and all connections made, unplug infinity, which is known to be "too much out." Press the battery-key B firmly down, and snap down the galvanometer key A1 so as to allow only a momentary current to go

through the instrument. Notice the way the needle swings, as this shows too much out of the box. Now get a resistance that will cause a swing the reverse way, which shows too little out of the box. The resistance must be so adjusted that contacts with key A1 do not affect the galvanometer when key B1 is kept permanently depressed.

In a line whose resistance has to be determined, there frequently exists a certain amount of current passing quite independent of the battery employed. This may be due to the earths at either end of the line being of different metals, or to a potential difference between the positions in which the earths are placed. This is known as a "sea-cell," and it is difficult to obtain a reliable measure of the line resistance, principally to its not remaining constant. The procedure is to press key A1 first, and when the deflection due to the sea-cell is steady, snapping contacts are made with key B1, and resistance adjusted until no effect is produced on the galvanometer by such contacts.

LECLANCHE BATTERY FOR FIELD SERVICE.

(Electro motive force = 1·46 volts; internal resistance = 0·15 ohms.

Each ebonite cell contains :—

(1.) A carbon plate in contact with four agglomerate blocks, two one each side of the plate. They are separated from the zinc plate by coarse canvas.

(2.) A zinc plate moulded to enclose the carbon plate and agglomerate blocks.

The top of the cell is sealed up with bitumen and plaster of paris, leaving only two holes, the larger of which is closed with a cork and the other with a piece of cane. The cell is charged by pouring a concentrated solution of salammoniac into the larger hole. The full electro motive force of 1·46 volts is never forthcoming while the cell is working; 1·3 volts is about the maximum. The resistance rises after the cell

has been working some time to about 1 ohm. The cells are made up into batteries of 10 and 6 cells each, contained in a deal box.

NOTE.—This battery will not be issued in future, but Obach dry cells will take its place.

Care must be taken when using Leclanche batteries not to complete the circuit for a longer time than is absolutely necessary, so as to avoid polarising the cell. In ordinary intermittent working on a telegraph line there will not be any danger of this. Considerable temporary damage will be done if the cells are short circuited through a very low resistance. This should therefore be guarded against. The plugs should always be kept in the holes in the top of the cell, to avoid waste by evaporation. The cane plug being porous allows of the escape of the liberated ammonia. The cell should be kept refreshed from time to time with salammoniac solution. If the resistance of a cell attains a value of more than 3 ohms it will require to be dismantled and washed out with warm water.

The internal state of a battery may be sufficiently accurately guessed at by noting the deflection produced on the two coils of the quantity and intensity detector, and comparing them with those produced by a battery known to be in good condition. A diminution in the deflection produced on the intensity coil will indicate that the E.M.F. of the battery is failing; while a low reading on the quantity coil, together with a normal one on the intensity coil, would denote a rise in the internal resistance. A rise in the internal resistance will not perceptibly affect the deflection on the intensity coil; but a diminution of the E.M.F. will equally affect both coils. The state of the latter should therefore be ascertained first, and, if found to be affected, an allowance must be made for it in the estimate of the internal resistance.

It is a good plan to keep a linesman's detector specially for battery testing, and the deflections indicated by it on both coils by the current from a good Leclanche cell noted.

The deflections should be checked from time to time, in case the magnetism of the needle should become injured. If the E.M.F. fails the cells need refreshing with salammoniac solution. No solid salammoniac should be introduced into the cell. If the resistance rises above about 3 or 4 ohms per cell the battery will have to be dismantled and thoroughly washed out with warm water. If the refreshing with salammoniac solution fails to restore the E.M.F. of the cell it is probable that the agglomerate blocks are used up. This will also be indicated by the cell becoming rapidly polarised. Under such circumstances the cell will have to be unsealed, and new blocks introduced, and the cell sealed up again. This cannot be done in the field, and therefore the battery must be replaced by another, while the defective one will have to be sent to the base to be made up again.

It should be remembered that it is of more importance in telegraphy to maintain the E.M.F. of a battery up to the proper standard than to keep its resistance down, especially if the circuit is a long one. This does not apply to the batteries used on local circuits, nor to those used for speaking on microphone circuits. In these cases it is desirable to have the resistance as low as possible.

Action of the Cell.—The action of the cell is as follows: The salammoniac solution attacks the zinc, and forms a chloride of zinc; hydrogen is given off as a free gas, and is prevented from quickly polarising the cell as it is taken up by the oxygen of the depolariser. If the cell is kept in action for a long time, if a strong current is taken from it, or if it is accidentally short circuited, it will polarise, in spite of the depolariser, and the E.M.F. will fall rapidly; but if left to itself will rapidly recover, and be capable of giving a fair current for a short time. The current flows from zinc to carbon through the solution in the cell, and from the carbon pole (the positive) to the zinc pole (the negative) round the external circuit.

Opening.—When it is found necessary to open sealed

Leclanche cells the liquid should first be emptied out. The sealed composition should be carefully chipped out by means of a small sharp chisel (about $\frac{1}{4}$ in.) and light hammer (say, 3 oz.). When this has been effected, the interior parts can be drawn out. It may be necessary to soak the cell in water for some time to admit of removal of zinc plate without the use of undue force; this plate should be examined, and if very thin or worn in holes, it should be condemned. Examine the carbon plate to see that there is no appearance of the formation of lead-chloride under the head, and that the binding-screw is securely fixed. The presence of lead-chloride will necessitate condemnation. The agglomerate blocks should in all cases be renewed. All other parts of the cell to be thoroughly washed, taking care that lead head on carbon plate is kept dry. The carbon plate should also be tested to see that there is no undue resistance in the brass terminal and lead head. A resistance exceeding 0·2 ohm should entail the condemnation of the plate. The zinc plate should be cleaned and amalgamated. The cell should now be put together. Care should be taken that the wood cover fits well at all parts, so that the compound may not run down into the cell.

LINEMAN'S DETECTOR.

The "lineman's detector," commonly known as a "Q and I" galvanometer, is essentially a two-coil galvanometer, with three terminals.

The magnetized needle is a small steel permanent magnet, moving freely in a vertical plane, and pivoted horizontally. The needle is normally retained in a vertical position by the preponderance of its lower limb and of the lower limb of the indicator in front of the dial.

The three terminals are on the top of the wooden case, which is also furnished with a ring, by which the instrument can be easily carried.

The right-hand terminal is lettered "Q" (*i.e.*, quantity*), the centre terminal is unlettered, and the left-hand terminal is lettered "I" (*i.e.*, intensity*).

The internal connections are shown in the diagram.

The quantity coil is wound next to the needle to a resistance of 0·2 ohms.

The intensity coil is wound over the quantity coil to a resistance of 100 ohms.

The intensity coil is used for localising faults on lines, and in all cases in which considerable resistance is in circuit with the galvanometer. The quantity coil is principally used for battery testing, and in cases in which the resistance in circuit with the galvanometer (and including that of the battery) is under 8 ohms.

In testing Leclanche cells on the quantity coil of a detector, to prevent damage to the cell, a key should be included in the circuit, and the glass in front of the detector should be removed. The key should be depressed for an instant, and the deflection of the needle followed up by the point of a pencil or other non-magnetic substance, so as to prevent the needle falling back again to zero. If when the key is again depressed for an instant the needle moves further, the pencil-point should be moved a little further also, until the position is arrived at where, the key being depressed, no further movement of the needle takes place.

This will be the true deflection due to the cell.

Care must be taken that the pencil is not pushed too far. This should be ascertained by moving it back a little, and again noting whether a depression of the key moves it further.

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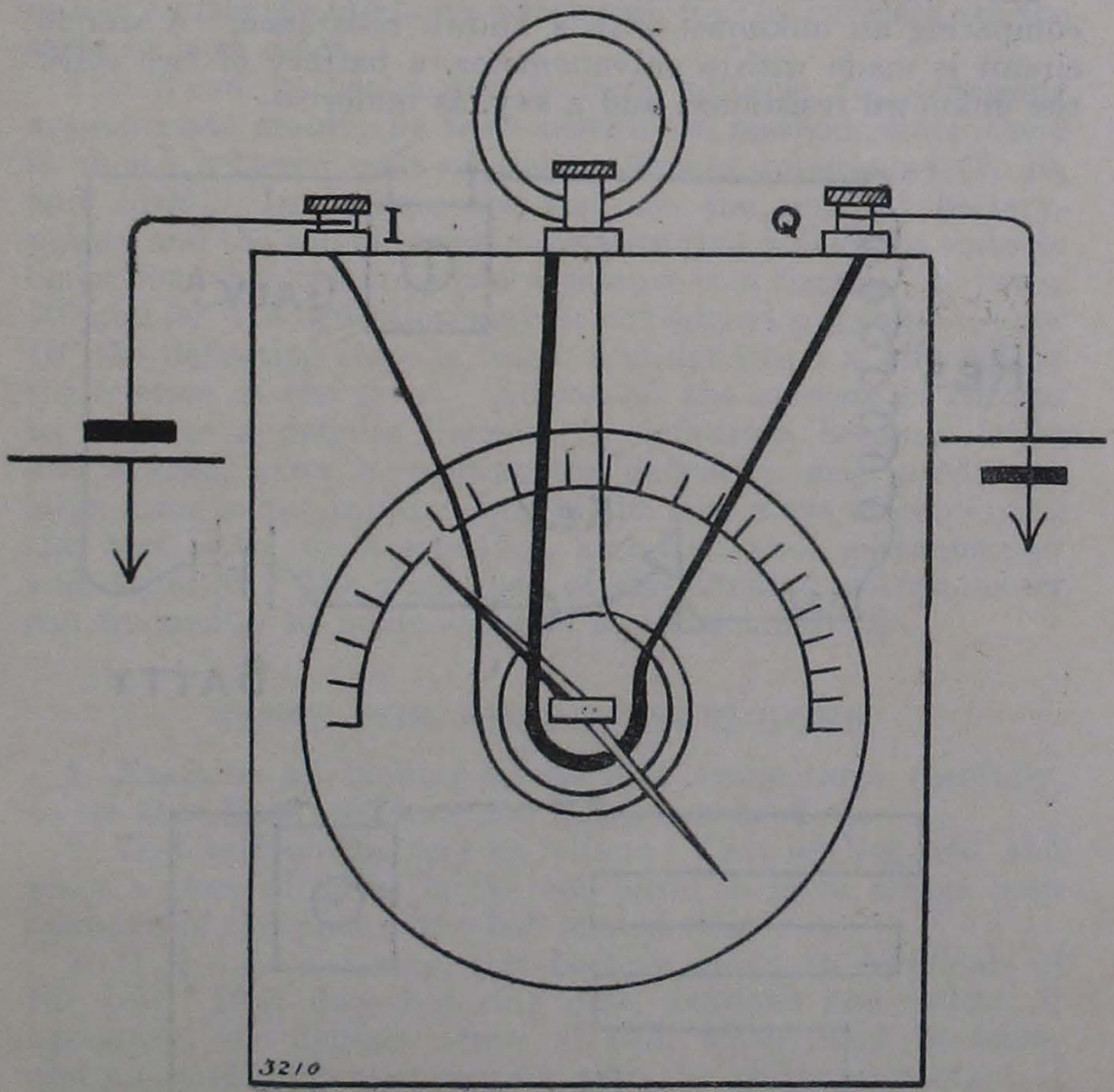
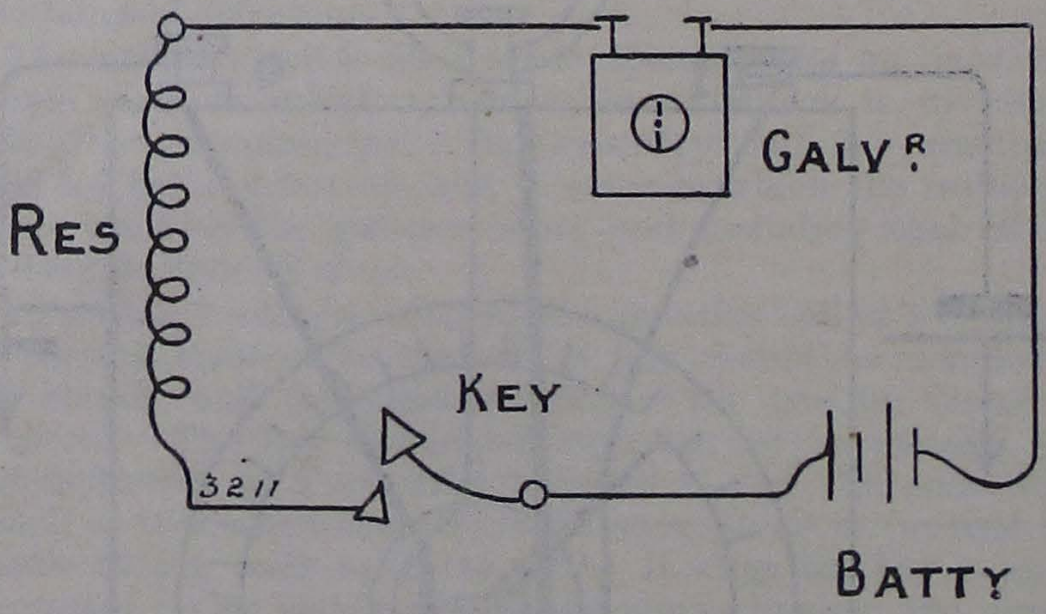
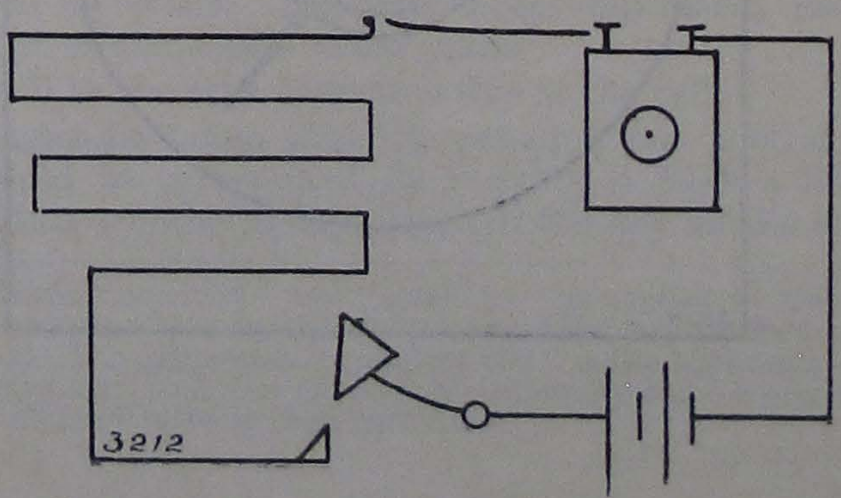
* The terms "quantity" and "intensity" as applied to the coils of a galvanometer, though sanctioned by long usage, are in themselves very misleading. The expression "quantity coil" really signifies a short coil of low resistance, and the expression "intensity coil" really signifies a long coil of comparatively high resistance.


I
Q
3210

"SUBSTITUTION" METHOD OF MEASURING AN UNKNOWN RESISTANCE.

The "substitution method" is a simple, direct method of comparing an unknown with a known resistance. A simple circuit is made with a galvanometer, a battery of two cells, the unknown resistance, and a key, as under :—





A deflection is produced on the galvanometer on depressing the key. A resistance-box is now substituted for the unknown resistance, and the resistance in box adjusted till same deflection is produced as before. Then the resistance in box equals the unknown resistance, for the currents are the same in both cases.

The 3-coil galvanometer is very suitable for obtaining approximate results by the substitution method, since there is choice between coils of three different resistances (2, 10, and 1,000). In making the test use the smallest battery-power, and the coil of lowest resistance that will give a suitable deflection when the unknown resistance is in circuit. Between 10° and 50° the deflection may be considered suitable. Below 10° the deflecting force is small, and deflection is affected by the friction at the pivot. Above 50° the increase of current to produce a definite increase in deflection becomes large, and a small error in reading the deflection may produce a large error in the result. One of the best ways of employing this test is to use a sensitive, high-resistance galvanometer and shunt it. The resistance of the shunted galvanometer can frequently be made so small as to be unreliable.

TESTS FOR ADER'S TELEPHONE.

1. Examine all binding-screws and connections carefully, to see that they are clean and tightly screwed up.

2. Test bell and battery as follows : Cast off line-lead and place a piece of metal in the bell-push, so as to bridge both contacts of the push ; the bell should ring.

3. If it does not ring, put battery direct to terminals of the bell. If it does not ring now, examine and adjust, if necessary, the contact screw of bell, which may be loose, and not making proper contact with the platinum contact of the spring that is riveted to armature of bell.

4. If it will not ring after readjusting, test the battery with a detector, and if it is found in good order the fault

must lie in the coils or leads in the base of the bell, which must be tested for with battery and galvanometer.

5. A test should now be made to see that the connections within the instrument are correct for calling the distant station. To test these, put the low-resistance coil of a detector between line and earth terminals, and press bell-push. There should be a violent deflection; if there is, the connections are right. If no deflection, there must be a disconnection in some of the wires of the instrument, which fact must be localised.

6. To test speaking-circuit: (*a.*) Disconnect line-lead and lift receiver off hook and place your ear, and tap lightly on the transmitter; no sound should be heard. (*b.*) Now short-circuit the line-terminals with a piece of wire, and repeat; sound should now be heard. If these two tests answer your speaking-circuit is correct. If sounds are heard when (*a*) is carried out, the line-terminals must be in some way short-circuited. If sounds are not heard when (*b*) is carried out, test the receiver and leads by touching with two wires from a battery the two terminals to which the receiver-leads are made fast, when loud sounds should be heard in the receiver. If sounds are not heard, try by taking two leads from the battery direct to the terminals of the receiver; if sound is now heard, there must be a disconnection in the leads of receiver; if sounds are not heard, the fault must be in the receiver; the iron diaphragm may be touching the poles of the magnet, owing to the brass spacing-washer being absent, or being too thin, or the coils of the magnet may be damaged.

To test the primary coil: Connect up a battery with low coil of detector and attach two leads. Join one lead to C terminal of transmitter, and the other to E Z terminal; a large deflection should be given. Receiver should be off the hook.

To test secondary coil and receiver: Connect up a battery with high-resistance coil of galvanometer, and attach two leads. Join one lead to E Z terminal of transmitter and the

other to L terminal; there should be a good deflection. The receiver should be off the hook.

If a fault is suspected in line, communication must be made with distant operator, who must be told to insulate his line. After he has done so, connect up a battery and high coil of galvanometer and attach two leads; join one to L terminal and the other to E. There should be no deflection; if there is, the line is short-circuited. Next instruct the distant operator to join his line-wires together. You should have good deflection on galvanometer; if no deflection, the line is broken.

To connect up the Ader Telephone with Chattering Bell.

Six or eight Leclanche cells required for bell-circuit; one or two of these can be used for the transmitter.

Join end of positive pole of battery to B C terminal.

Join end of negative pole of battery to Z E terminal.

Join positive pole of end cell to C terminal.

Join bell-terminals to terminals marked "Bell."

Join receiver to small screws provided on front of transmitter. If only one receiver is in use, the two screws on the left side must be joined by a small piece of wire.

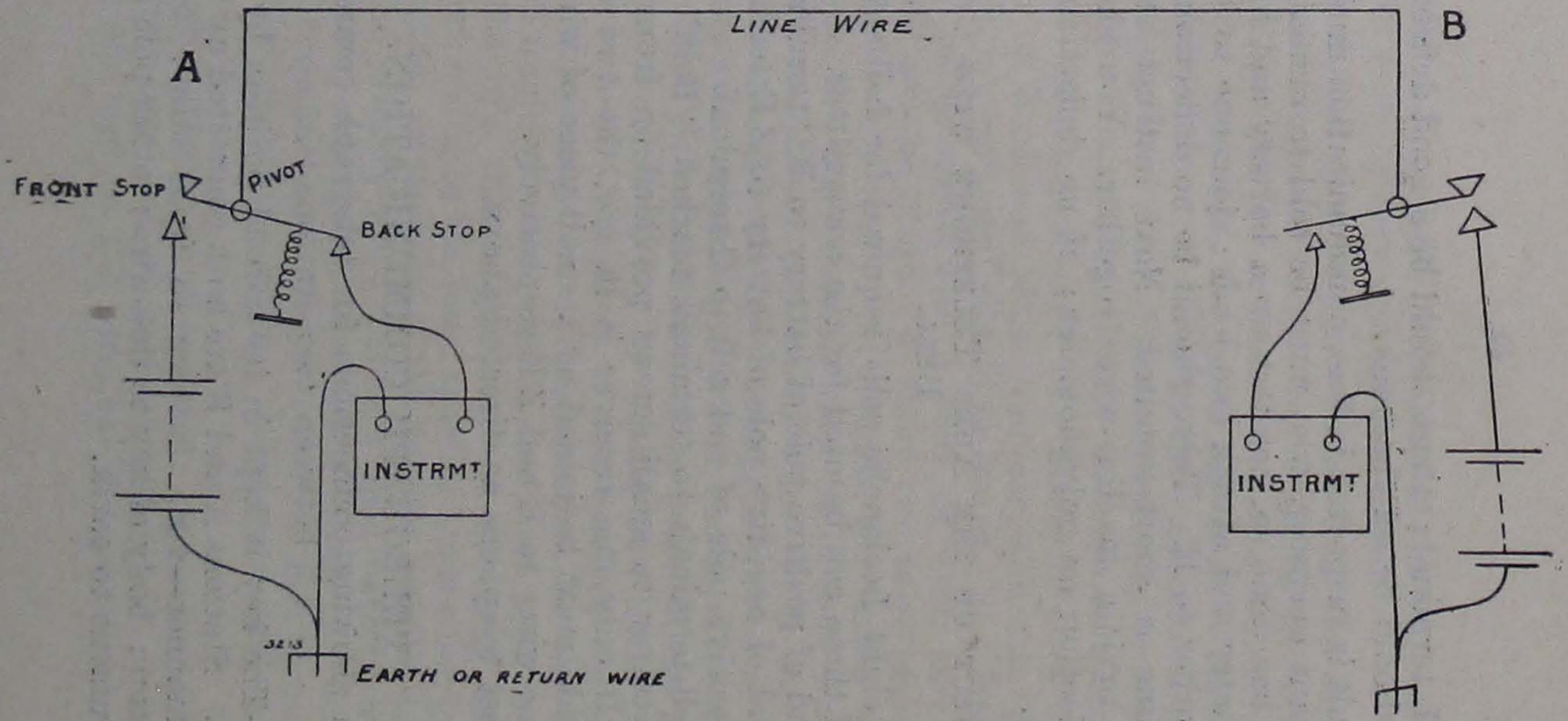
Join line-wires to L and Z E respectively.

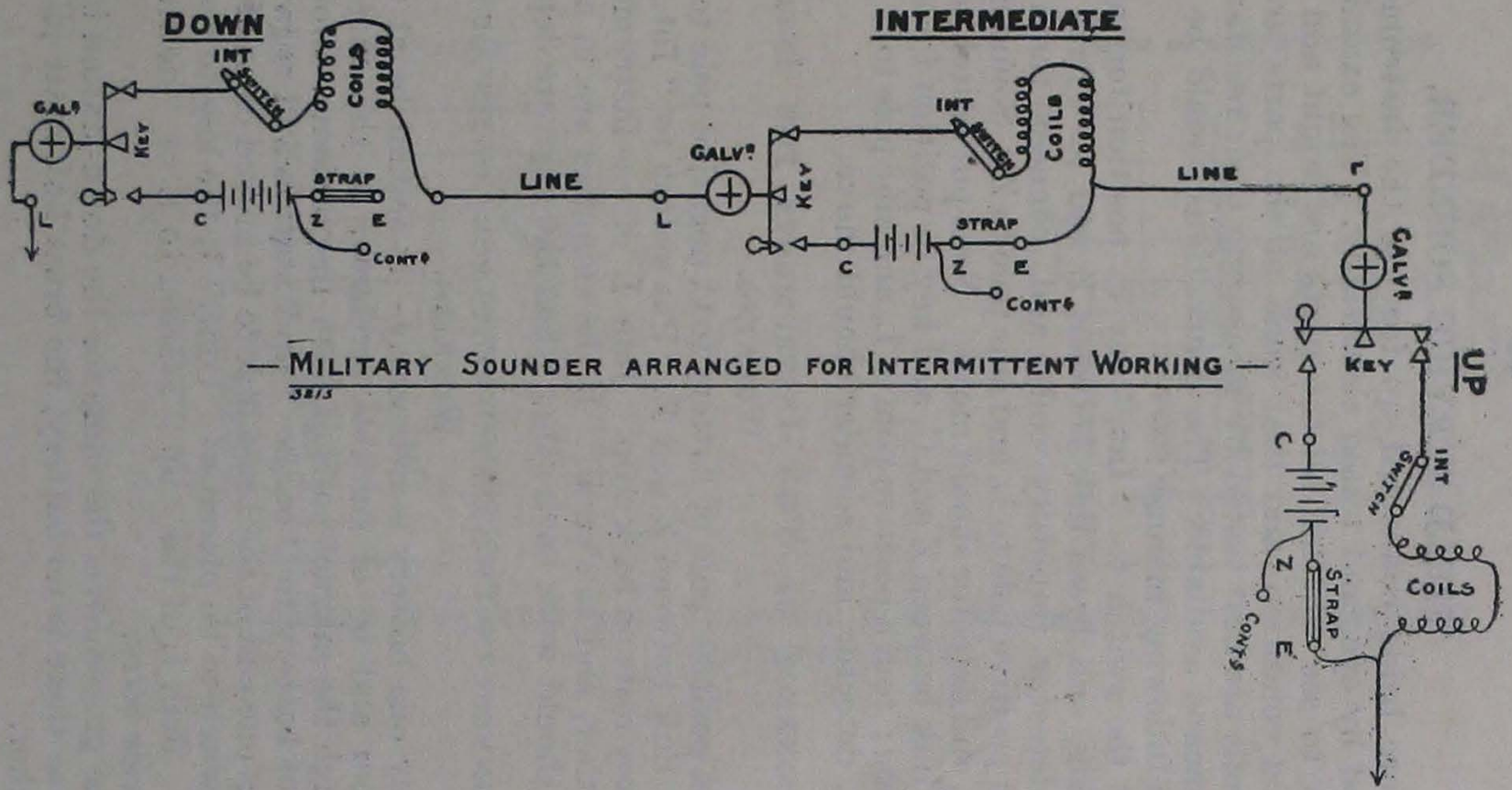
Now test telephone as directed above.

TELEGRAPH COMMUNICATION.

(Diagram showing connections for telegraph communication between two stations.)

Note.—The key is kept in its normal position by a spring, as shown. Stations A and B are both connected up in exactly similar manner—viz., battery to front stop; instrument to back stop; body of key to line-wire; other pole of battery and instrument to earth.


LINE WIRE
A
B
FRONT STOP
PIVOT
BACK STOP
INSTRMT
INSTRMT
3213
EARTH OR RETURN WIRE



— MILITARY SOUNDER ARRANGED FOR INTERMITTENT WORKING —

3813

FIELD SERVICE SOUNDER.

Before being connected up for use the instrument is examined by eye, and tested electrically. The examination by eye is to see whether all the parts are bright and clean and in good condition, and that none of the parts are missing. The coils are best tested by measuring their resistance by the best means available. The connections should be examined in the following manner :—

Put the switch to "Int." key in position for intermittent working, and brass link between Z and E. Take a battery and detector (intensity coil), and connect them together. Touch positive pole to L, and zinc pole to Z. Sounder, galvanoscope, and detector should move. Next put switch to "Cont.," brass link between Z and C, and key in position for continuous working; touch positive pole to L, and zinc pole to E; galvanoscope, detector, and sounder should move.

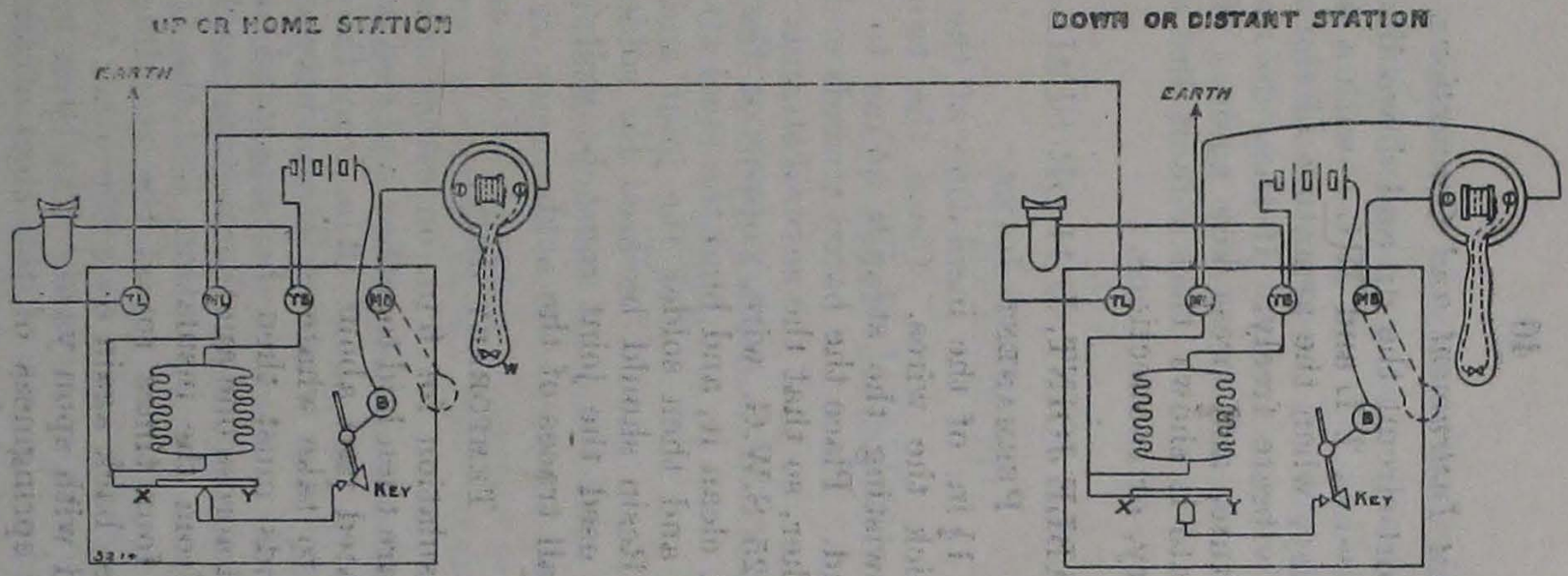
To connect up Two Instruments for Intermittent Working.

Join positive pole of battery to C, negative pole to Z; place brass link between Z and E. Put switch to "Int.," and see that key rests on back stop. Join L of one instrument to E of the other, and *vice versa*. If the sounders are in adjustment they should work each other when the keys are depressed.

To connect up Two Instruments for Continuous Current Working.

Only one battery is necessar.y It should be at the "up" station, and be of suitable strength, as the current passes through the magnet coils of both instruments. Join positive pole of battery to C of the "up" station and negative 1 pole to Z; one end of the brass link to be moved clear of terminals, the switch to be placed at "Cont." 1, the key to rest on front stop. Join L of the "up" station to E of "down" station, and *vice versa*.

The procedure is the same for the down-station instrument, but, as there is no battery, the brass link must join Z and C together.



VIBRATING TRANSMITTER ARRANGED FOR TELEGRAPHIC OR TELEPHONIC COMMUNICATION.

duty he is about to undertake. He will obtain as much information as he can regarding the route to be followed by his detachment, the communication he is required to establish, and all other communications to be established.

Office-calls.

He will ascertain the code call of his cart office, of the base office, and all other offices on the system. He will communicate this information to his detachment.

Commencing Work.

Duties of Numbers.

Commander.—On arriving at the place from which the cable-line will start he will give the order "Commence work," when the detachment will proceed to pitch a tent for the base office if no office accommodation is available, and the detachment will proceed to carry out the following duties.

Duties of No. 1.—Takes his complete office equipment from the box in cart, joins his instrument to the cable-line and to the earth-lead, and establishes telephonic and telegraphic communication with No. 2 on cable-cart.

Duties of No. 2.—Assists No. 1 to get his stores out; then joins up his own instrument on cart to inner end of line and to earth on wheel; then takes his seat on front of cart, and exchanges call with No. 1. As soon as the circuit is working satisfactorily he calls out "Through" to the Commander. From this time on he will remain in his place, giving strict and constant attention to his instrument, until properly relieved by order of the Commander.

Duties of No. 3.—Unfastens the end of cable from the drum, and pays out the cable as required. He hands the end of the cable to No. 1, and makes the cable fast at the office with a clove hitch, so that the end is not dragged away when the cart starts to move. He then gets the apron and gloves from the box on cart, and takes his seat in rear of the cart, ready to pay out the cable.

Duties of No. 4.—Takes hammer, jumper, and earth-pipe from the cart. He jumps hole for earth-pipe as described by the Commander, and fixes it firmly in the hole, and hands the end of the earth-lead to No. 1. He then returns the hammer and jumper to the cart, and takes a crook stick from the cart, and prepares to work behind the cart at a distance of about 20 yards.

Duties of No. 5.—Assists No. 4 to jump hole and fix earth-pipe. He takes a crook stick from cart, and prepares to work behind the cart at a distance of about 50 yards.

Duties of No. 6.—Takes portable telephone, length of cable, tubing, and pegs from cart, and remains at base office to deliver messages and search for fault in case of communication being interrupted.

Laying the Cable.

Duties of Numbers.

Commander.—The Commander is responsible for the laying of the cable, the work of the office on the cart, and the discipline of the detachment. His normal position while laying the cable is close in rear of the cart, on the opposite side of the road to that on which the cable is being laid. He controls the pace of the cart. He will watch the cable carefully as it is paid out, and direct No. 3 to pay out faster or slower according as more or less slack is required for it to lie well. When the safety of the line makes it necessary that it shall be tied back at once, he will order No. 5 to tie back.

When it is necessary to carry the cable over a track or road he must decide quickly how the crossing is to be made. The words of command are, "Pole crossing," "Tree crossing," "Pole and tree," or "Bury."

He will receive the word "Through" from No. 2 every time the cart halts, and will give him the position of the cart to be telegraphed to the base office.

As soon as any interruption of communication occurs it is

the duty of the Commander of the cable detachment to take immediate action. He will first test his end of the circuit, and ascertain that the fault is not in the cart.

The complete test of the cart and its equipment is to join a portable telephone to the cable just behind the cart and to earth. If perfect signals are received in the telephone the fault is beyond the cart.

If the fault is beyond the cart he will decide whether the detachment will remain halted or continue to lay cable while the line is unworkable.

He will take care not to expose his detachment unnecessarily to the sight or fire of the enemy, to leave roads and approaches clear for traffic, and to save his horses by dismounting the sappers and drivers whenever possible.

Duties of No. 1.—He will be in charge of the base office, and give strict and constant attention to his instrument, and will not leave it for a moment unless properly relieved. He will keep up communication with No. 2 while the cart is on the move by merely touching the key.

In the event of any unduly long interval between the signals from No. 2 he will send the lineman out to remove the fault. He should receive signals from No. 2 every two minutes.

If he has a message to send while the detachment is on the move he will offer it to No. 2, but will not insist on sending it until No. 2 is prepared to accept it.

He will keep copies of all messages received and despatched.

Duties of No. 2.—While on the move No. 2 will press his key at intervals of about two minutes, receiving the signals of the base office in return. If he fails to receive signals from the base he will at once so inform the Commander.

Whenever the cart is halted for any purpose he will get into communication with the base office, and, as soon as he is satisfied that the signals are good, will call out "Through to the Commander. He will then telegraph to the base office such information as he can give regarding the position of the cart.

If he is offered a message by the base office while the detachment is on the move, he will inform the Commander, who will decide whether the cart shall be halted to receive the message or not.

He will keep copies of all messages received and despatched.

Duties of No. 3.—Pays out the cable by pulling it off the drum with his hand, and lets the cable run through his hand as it pays out, taking care that the slack does not catch on any projection of the cart. He will pay out very freely when the cable is being laid on the outside of a curve in the road.

Duties of No. 4.—Works 20 yards in rear of cart, laying the cable with his crook stick in the position in which it is to remain. He should proceed along the line in which the cable is to be laid, irrespective of where the cart goes, and should shout to No. 3 if the latter pays out so much slack that the cable sags between drum and crook stick enough to catch on obstacles.

When working round the outside of a curve in a road where the strain would pull the cable out in the road, he can save a great deal of tying-back by looping the cable over bushes or stubs or stones which will hold it in. He should loop it over something every 10 or 20 yards, choosing a definite bush or stub for the purpose, and glancing behind him to make sure that the cable has been caught by it neatly.

On the command "Joint," he takes the end of the two cables, and stands on the new one, with a turn round his foot to take any strain that may come from the cart. He then makes the joint.

On the command "Tie back," he ties back the cable to a natural holdfast, or to a peg driven by him.

Duties of No. 5.—Works about 50 yards in rear of the cart. The final responsibility for the safety of the line rests on him. He should thoroughly understand what faults in laying a line are to be avoided. He will on his own responsibility correct any faults he finds, tying back and burying the cable where necessary. If the line has been laid too tight, and has been pulled across roads, he may have to put in an addi-

tional length of cable. He should not waste time, but need not hurry through his work.

Duties of No. 6.—Delivers messages as required. On being ordered by No. 1 to proceed in search of a fault, will at once start to discover the fault, inspecting the cable carefully as he rides along.

On being sent in search of a fault he will be equipped with a portable telephone, a crook stick, and a length of cable. He will inspect the cable carefully as he rides along, and, until he has reached the fault, he will come in circuit at every joint with his telephone. If he receives signals only from the office from which he started, he has not yet reached the fault, and must proceed further. If he receives the signals of the other office only, he has passed the fault, and must return again, inspecting the cable very carefully, and now using his telephone frequently until he has located the fault.

His duty is not completed when he has repaired one fault. He must make sure that communication has been properly re-established before he returns.

Pole Crossing.

Duties of Numbers.

Commander.—On the command "Pole crossing," the cart halts beyond the place where the crossing is to be made. The Commander superintends and directs where to jump holes and drive pegs so as to get all the poles and pegs in line.

Duties of No. 2.—Reports to Commander if through.

Duties of No. 3.—Pulls out 12 yards of slack; gets a pole, a guy line, a peg, and spun yarn. He works at the hole furthest from the cart, puts the pole together, makes off the cable to the top of it with a clove hitch, allowing slack enough behind him to reach down the pole and leave a little slack at the bottom. He makes off the guy to the top of the pole, then holds the top of the pole over the hole that has been jumped by No. 5, and on getting the word "Up" from No. 4 he

raises the pole, places it in the hole, and presses it down firmly. He then ties the slack of the cable in a coil down to the foot of the pole, and makes off guy line to the peg.

Duties of No. 4.—Gets a pole, a guy line, a peg, and spun yarn from the cart. He works at the hole nearest the cart, puts the pole together, and makes off cable to top of it with a clove hitch, after pulling it up tight from No. 3's pole. He makes off the guy to the top of the pole, then holds the top of the pole over the hole that has been jumped by No. 5, and when No. 3 has called out "Right," gives the word "Up," when both poles are raised. He then presses his pole down firmly, and ties slack of the cable in a coil down to the foot of the pole, and stands on the cable, with a turn round his foot, until the strain is off it.

Duties of No. 5.—Gets hammer and jumper from cart, and jumps a hole for the pole nearest to the cart, and drives in pegs where directed by the Commander. He then jumps hole for pole furthest from cart, and drives in pegs as directed, and returns jumper and hammer to the cart.

Tree Crossing.

Duties of Numbers.

Commander.—On the command "Tree crossing," the cart halts beyond the place where the crossing is to be built. The Commander superintends and directs Nos. 3 and 4 which trees to use and how far up to tie the cable.

Duties of No. 2.—Reports if through.

Duties of No. 3.—Pulls out about 12 yards of cable, then climbs the tree furthest from the cart, and makes the cable fast to it.

Duties of No. 4.—Climbs the tree nearest to the cart, and makes the cable fast to it.

Duties of No. 5.—Gets the ladder from the cart, and holds it while Nos. 3 and 4 climb the trees. When the crossing is completed he returns ladder to cart.

Bury Crossing.

Duties of Numbers.

Commander.—On the command "Bury crossing," the cart halts beyond the place where the crossing is to be made. The Commander superintends and directs Nos. 3 and 4 in which direction to pick the trench.

Duties of No. 2.—Reports if through.

Duties of No. 3.—Pulls out 3 or 4 yards of slack, fetches a pick from cart, and starts to pick a trench along the line of the crossing, starting from the centre to the rear. After No. 5 has dug out the trench, lays the cable in it, working from the centre, and covers the cable over with earth. He then returns pick to cart.

Duties of No. 4.—Fetches a pick from cart, starts to pick a trench along the line of crossing, starting from the centre to the front. After No. 5 has dug out the trench, lays the cable in it, working from the centre, and covers the cable over with earth, and then returns pick to cart.

Duties of No. 5.—Fetches a spade and peg from cart, and digs out the trench Nos. 3 and 4 have picked. He then drives a peg in at the front end of the trench, making off the cable to it with spun yarn. He then returns spade to cart.

Reeling up.

Duties of Numbers.

Commander.—His position is close in rear of the cart, where he can watch Nos. 3 and 4. He must stop the cart if the cable gets caught up anywhere.

Duties of No. 2.—Works the handle of drum reeling the cable on.

Duties of No. 3.—Sits at the back of the cart and lets the cable run through his hands as it is reeled in, distributing it evenly over the drum.

Duties of No. 4.—Works in rear of the cart, holding the loop of the cable in his crook stick, and thus clears it off the

ground while it is being wound on the drum. He assists No 5 to take down crossings and return stores to cart.

Duties of No. 5.—Works ahead of the cart and clears cable, so that it can be reeled up without delay. He will clear it away from all bushes, &c., on which it may be caught, leaving it lying clear of the road. Wherever the cable has been tied back he will remove the spun yarn. He will clear the cable from buried crossings, and he will, assisted by No. 4, take down "pole" and "tree" crossings and return stores to the cart.

INSTRUCTIONS FOR LAYING FIELD CABLE-LINES.

Laying Field Cables.

Details of Laying.

In laying cable-lines the result to be aimed at is the safety of the cable. No rules as to where the cable should be laid can be given; this must be decided by the particular circumstances in every case. As a rule, the further it is from metalled roads where much traffic will pass, the better. Men and beasts will, especially at a check, move along the sides of the roads.

The paying-out should be so regulated that the cable lies evenly on the ground everywhere. If it is stretched across a hollow in the ground, and is thereby not in contact with the ground, there is danger lest some one passing may trip in it, and break or drag it out of place.

It should be stretched out without any strain on it, but also without leaving it in loops or coils.

It should never be stretched off the ground across gates or gaps in hedges through which men or animals may pass, or in any situation where it will interfere with traffic.

It should be laid out of sight, if possible.

It should never be allowed to lie in water, or the current will leak to earth.

Over Open Ground.

If the cable is laid across an open space, care should be taken to lay it just stretched on the ground, and it should be pegged down every half-mile.

Along Tracks.

When the line follows a sandy track through bush or heather, it is generally best to lay the cable in the track where traffic passing over it will not injure it.

In Front of Dwellings.

In laying cable in front of dwellinghouses it can be allowed to lie on the surface of the ground, but it should then be laid fairly tight, quite flat, and pegged down on each side so as not to trip up men or horses.

In Villages or Towns.

The only safe position for cable passing through large villages or town is fastened high up on the buildings. This entails slow progress, and in peace the consent of the inhabitant is necessary. If it is absolutely necessary to pass quickly through a town, and consequently to take risks, the best place for the cable is the gutter by the side of the footpath. The cable should be frequently tied down to the gratings of the surface drains, or to pegs.

Lines should be laid apart.

Cable-lines should be laid as far apart from each other as possible. If two lines lay alongside each other for any considerable distance, the signals on one line interrupt the signals on the other, owing to electrical induction.

Road-crossings.

When cable-lines cross roads on tracks the cable should be raised at least 15 ft. over the roadway, or should be buried under the surface.

The cable should only be buried across soft and unmetalled tracks. Buried crossings are liable to cause earth faults in wet weather.

Twenty-four 17 ft. jointed poles are carried on each cable-cart, by means of which the cable can be raised over roads.

When a pole crossing is necessary, a hole 18 in. deep is made for each pole with a hammer and jumper. The tops of the poles are held over the holes, the cable is stretched between them and made fast to the tops of the poles by means of clove hitches taken in the cable. Sufficient slack should be left in the cable on each side of the crossing to admit of the poles being raised and of the cable being tied to their bases after erection. The poles are then simultaneously raised into their holes, and are stayed back with one guy line each.

The guy lines are made fast to trees, fences, or any other available holdfast, or, if none are available, to pegs which will be driven into the ground.

If buildings or trees to which the cable can be attached are available, the line should cross by these.

A road may also be crossed by means of one pole and one house or tree attachment. In this case the pole will be erected first, and the cable will be drawn taut over the road from the top of the pole to the house or tree to which it will be attached.

Railway-crossings.

When a cable-line has to cross a railway it should be cut and passed under the rails. Care should be taken to keep it clear of all railway-points.

Attachments.

The best way of making cable fast to a projection on a building, tree, fence, the foot of a pole at a crossing, or to any other holdfast is by making a barrel hitch with a piece of spun yarn through a loop or coil of the cable (see Fig 1), and tying off the ends of the spun yarn to the holdfast.

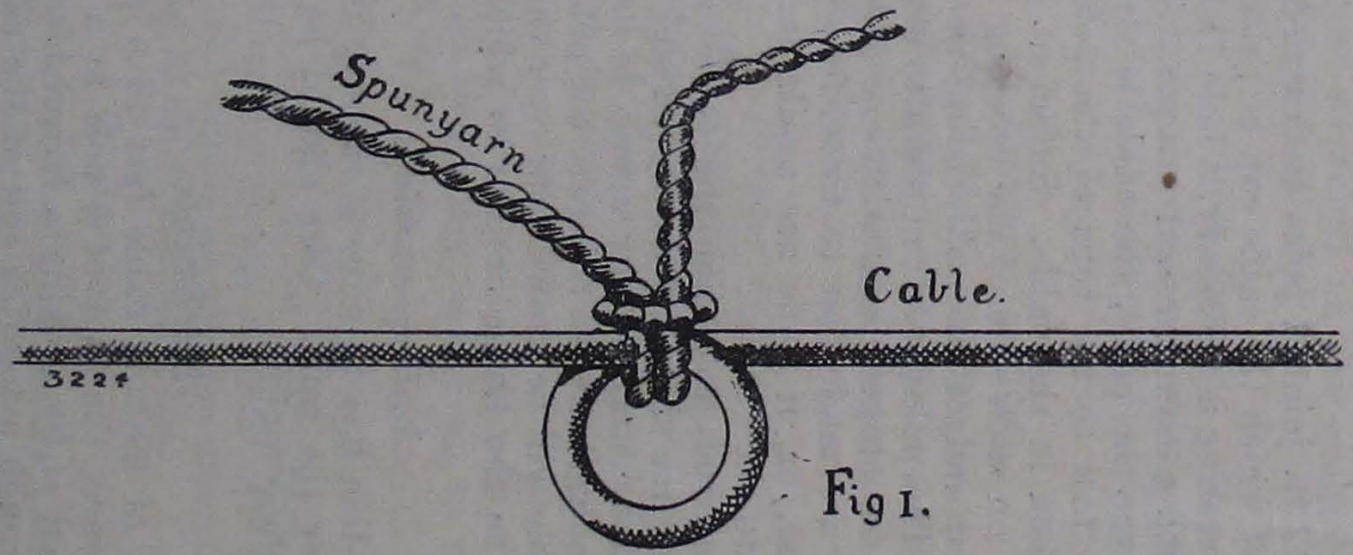


Fig 1.

Occasionally it may be found more convenient to make a clove hitch with a bight of the cable round a stout holdfast such as a large bough or a fencing-post. If this is done, care must be taken to see that the end of the bight is secured so that the spring of the steel in the cable will not cause the clove hitch to become slack.

Tying back.

In many places it is necessary, and in any case it is advisable, frequently to tie the cable back to gates, hedges, and fences on the side of the road.

Tying back is especially necessary when the cable follows the outside of a curve in the road, where it is liable to be dragged across the road if any strain comes on it.

The cable should be tied back as near to the ground as possible.

Temporary Joints.

The outer end of the cable on each drum will always be kept prepared for jointing as follows (see Fig. 2).

The insulation should be stripped from a point 1 in. from the end of the cable for about 3 in., and a piece of indiarubber tubing from 5 in. to 6 in. long should be slipped on to the cable.

The inner end of the cable on each drum is similarly prepared, but has no tubing on it.

When a joint has to be made the ends of the cable will be tied together with a reef knot, which will be formed on the uninsulated part of the cable (see Fig. 3). This knot will be drawn as tight as possible, to insure good contact. The indiarubber tubing will then be drawn over the joint to insulate it.

Whenever it is necessary to make a temporary joint in cable the ends will be prepared, and the joint will be made and insulated as described above.

The short length of insulation left at the end of the cable serves to hold the strands of the cable together.

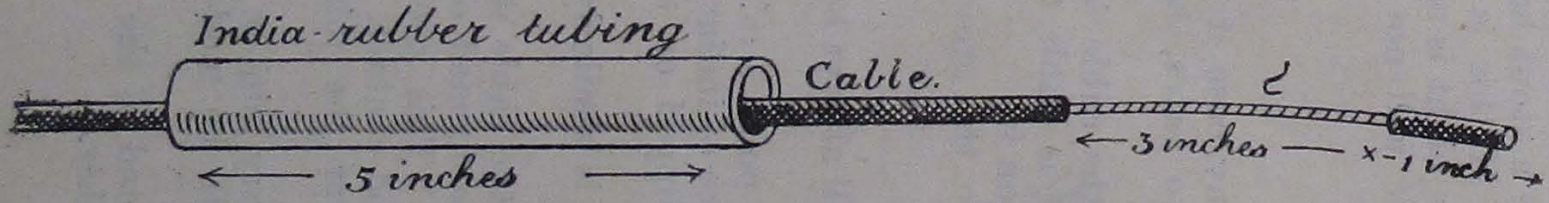


Fig: 2.

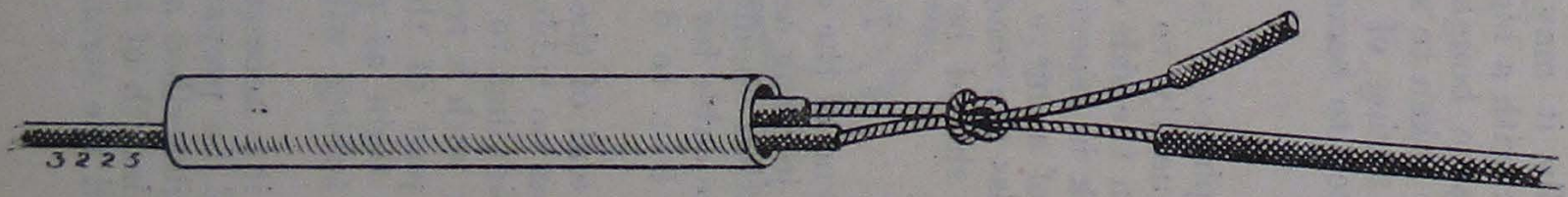


Fig: 3.

Earths.

The earth of the circuit on the cable-cart is formed by the contact of the tires of the wheels with the ground. In dry weather this earth is often found insufficient to give good signals. An earth-pipe is provided on the cart to supplement this, and whenever the cart is halted to send or receive messages, this additional earth should be used.

A good earth for a vibrator or telephone circuit can be obtained by driving a nail or the point of a knife into any living tree or bush, and leading the earth-wire to it.

Care of Cable.

Repairing Insulation.

Every opportunity should be taken of running through the drums of a cable, to repair the insulation, and make temporary joints permanent.

Bared insulation is repaired by smearing the place with indiarubber solution, and binding round with indiarubber tape.

Permanent Joints.

To make a permanent joint, remove about 3 in. of insulation and clean the ends, untwisting the strands so as to clean every part of each strand. Tie the bared ends together in a reef knot, pulling it up tight, and bind round closely with a piece of wire, and then solder in the usual way. Wash the joint well with water to remove all traces of the soldering fluid, dry, and serve with indiarubber tape and solution, being careful to make the tape overlap the original insulation by $\frac{1}{2}$ in. on each side.

Base Office.

Cable-lines will usually start from a field telegraph-office,

which will become the base of one or more moving offices on cable-carts.

On commencing work at this office each cable detachment will leave a complete vibrator-office and an office telegraphist. When several lines radiate from the base office, it will usually also be necessary to leave a N.C.O. as telegraph master, and one or more mounted linemen.

If no office-accommodation is available a *tente d'abri* will be pitched for each office set. Each set will have its own "earth," and these should be separated as far as possible.

One distinguishing flag is sufficient for a base office, although it may include several office sets.

It is convenient to make fast all the cables to the foot of the flagstaff, and lead them thence to a commutator, to which all the vibrators will be joined, so as to facilitate putting moving offices into direct communication with each other.

Before beginning to lay cable the Commander of each detachment must ascertain that the set on his cable-cart is working through to the base office.

AIR-LINE DRILL.

In Open Country.

Squad.—Three N.C.O.s and eight men in two ranks of four each.

One N.C.O. is mounted, and has charge of the drivers and horses; he also makes himself generally useful in carrying stores, &c., if required, and communicates with rear party when necessary, using small flag.

The senior dismounted N.C.O. has charge of the squad, and keeps with the fore party, selecting the position of the poles where there can be any doubt, and deciding all details

as to stays, double poles, &c. He superintends the fore party, consisting of Nos. 1 and 2 front and rear ranks, and No. 4 rear rank.

The junior N.C.O. has charge of the rear party, consisting of Nos. 3 front and rear rank and No. 4 front rank. He sees that Nos. 3, in straining the wire, keep their proper interval, superintends, and assists No. 4, and signals with the small flag to the mounted N.C.O. should his services be required, to fetch poles, &c., in case of breakage. He is responsible that the line is properly erected, and that the rear party keeps its proper interval of three poles from the fore party.

Nos. 1 front and rear rank carry hammer and jumper, make holes 80 yards apart, 18 in. deep, under the superintendence of the senior N.C.O.

Nos. 2 front and rear rank carry a pair of pliers each; they pay out the wire from the barrow, looking out for kinks and jointing where necessary, and winding up the slack. They keep near the wagon, and change rounds with Nos. 1 it necessary.

Nos. 3 front and rear rank carry pair of pliers and apparatus for straining the wire; they strain the wire at a distance of a span and a half in front of the pole at which No. 4 front rank is working, taking the strain alternately.

No. 4 front rank carries a small mallet, a supply of binders, and a pair of pliers; he binds in and erects line, taking care that the head of the pole is placed about 4 in. away from the hole when binding in, and towards finished portion of the line he attaches and makes fast stays and sees stay-pegs are secure.

No. 4 rear rank is in rear of wagon; he prepares poles as necessary, fixes insulators, places the poles in the holes, drives in stay-pegs, and places stay-wires over pegs.

In taking down the line each number undoes what he did in erecting, the Nos. 1 assisting in reeling up the wire, which may be done on the ground or on the wagon as convenient.

The poles should be left in the holes, and the stay-wires should be coiled and placed over the stay-pegs for No. 4 to collect.

Air-line Drill.

Squad.—The squad consists of two N.C.O.s and eight men in two ranks of four each.

If a cable-wagon is available a third N.C.O. is required to take charge of the drivers and horses.

The squad members off from one to four. Nos. 1 and 2 front and rear rank, and No. 4 rear rank with the senior N.C.O. form the *advance party*. No. 3 front and rear rank and No. 4 front rank with the junior N.C.O. form the *building party*.

Duties of Numbers forming Advance Party.

Nos. 1 front and rear rank jump holes.

No. 2 front and rear rank pay out wire from barrow.

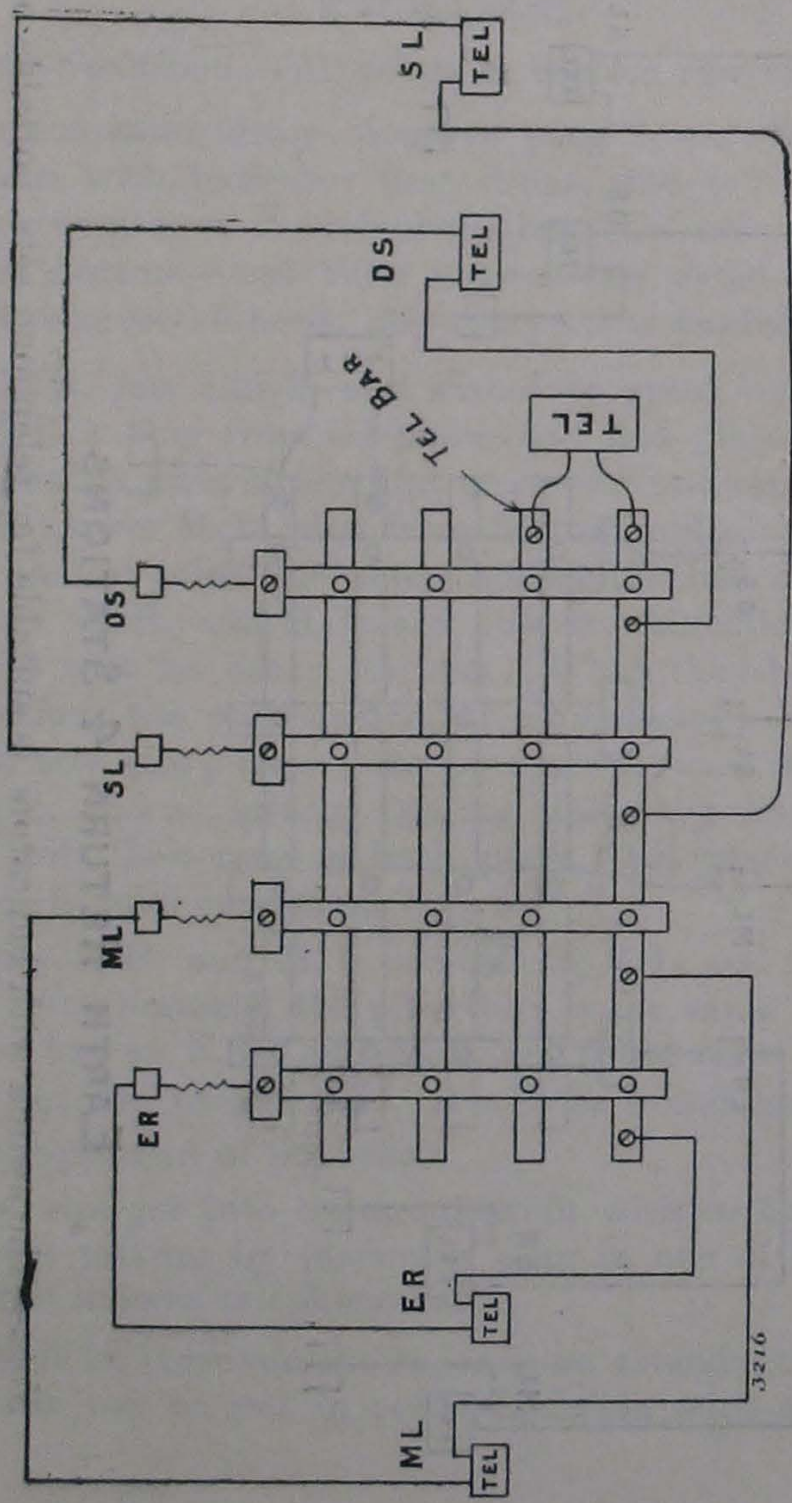
No. 4 rear rank fixes insulators to poles, drives in pegs, and leaves guys where required.

Duties of Numbers forming Building Party.

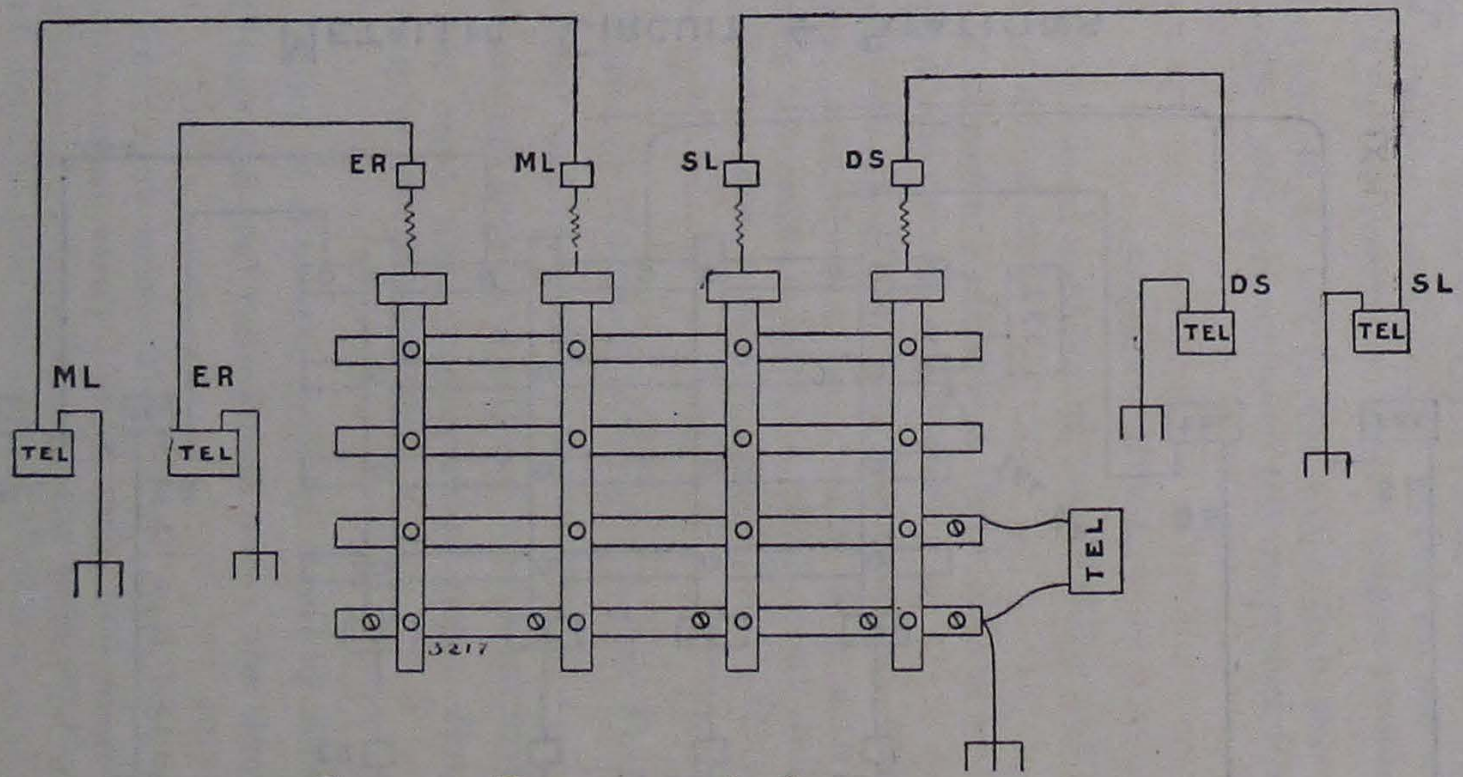
Nos. 3 front and rear rank strain wire; the strain is always kept on.

No. 4 front rank takes down poles, fixes line-wire in insulators, binds in at every fourth pole, and at all angle and terminal poles; erects poles, fastens guys to stay-pegs, and fills round base of pole with small stones.

SIMPLE FIELD TELEPHONE EXCHANGE.



3—Field Engineer Volunteers.



Earth Return 4 Stations

Note.—The switch with indicators is suitable for telephone sets, portable or office, but not suited to vibrator sets if indicators are made use of.

INSTRUCTIONS FOR WORKING TELEPHONE EXCHANGE.

Normal Condition.—All plugs in bottom row of holes.

If an indicator drops, remove plug from end of bar in connection with indicator that drops, and join this bar by means of the plug to the telephone-bar—*i.e.*, second horizontal bar from bottom—and then answer the caller by ringing; then lift receiver off hook, and ask what is wanted.

Say E. R. has called, and wishes to speak to M. L.: Remove E. R.'s plug from telephone-bar, and place it in E. R.'s bar, so that it joins either first or second horizontal bar from top, and remove M. L. plug from bottom and place it in M. L. bar, so that it joins the same horizontal bar that E. R. is joined to. E. R. and M. L. are now in connection with each other, but with no other stations. When they have finished conversation, the one that called up exchange—*i.e.*, E. R.—will give two sharp rings; these rings will cause the armature to vibrate, and so inform Central that they have finished. Central will then remove both plugs, and place in bottom row—*i.e.*, normal condition.

If while E. R. and M. L. are talking S. L. and O. C. should wish to communicate, the procedure is the same except that the same bar as E. R. and M. L. are using must not be employed, but the vacant bar. It will be found that each circuit is independent of the other.

Central can get into communication with or hear any two subscribers talking by placing a plug in one of the bars in use so that it joins telephone-bar.

Should it be inconvenient to leave an attendant at Central, all stations can be put in communication with one another

by removing plugs from bottom row and placing them in either top or second from top row.

GENERAL INSTRUCTIONS REGARDING USE OF TELEPHONES.

Interrupted Communication.

1. When communication is interrupted each operator will—

(*a.*) Carefully test his own telephone and its connections.

(*b.*) Endeavour to call up the distant telephone-station by repeated calls.

(*c.*) If after an interval of five minutes communication has not been restored, the N.C.O. in charge or senior soldier at any station will send a man, or himself proceed along the line to discover and repair the fault.

Men should in this way start from both ends of a broken line simultaneously, and, passing the cable through their hands and examining it, walk towards each other until they meet.

If a break is found in the cable it will be repaired at once.

If a spare telephone is available, it should be connected to the line and to earth, and the telephone-stations at each end of the line should be called up to ascertain if the line is again in working-order.

It must be remembered that the line may have been cut in several places, and that to repair one break only is not necessarily enough to re-establish communication.

2. When it is necessary to establish communication, or to localise a fault, at a place on the cable between joints in its length, connection with the core can be made without stripping the insulation by driving an ordinary pin or safety-pin through the insulation and the strands of wire. A telephone can then be joined in circuit between this pin and an "earth."

3. When a message cannot be promptly sent either through a temporary breakdown or a press of work, the N.C.O. or base operator will at once inform the Commanding or Staff Officer who is nearest the office.

Instructions for the Transmission of Written Messages through Telephones in the Field.

1. Although the telephone is essentially an instrument for conversation between officers, it sometimes happens that written messages, usually information and orders, have to be sent and received through it.

2. In order to insure accuracy and to introduce a uniform system, the following instructions have been drawn up for the guidance of operators transmitting and receiving written messages :—

Operators using Telephones with Vibrator-cells when—

Sending a message—

(1.) Call up the station you want by pressing the vibrator-button, and put the telephone-receiver to your ear.

(2.) On hearing answering call, say "Hullo," "Who are you ?"

Receiving a message—

On hearing a call reply by pressing the vibrator-button, put the telephone-receiver to your ear, then wait.

Answer sender's question thus : "Here, First Brigade Head Quarters."

Operators using Telephones, &c.—coutinued.

Sending a message—	Receiving a message—
(3.) Say, "Message for....."	Get pencil and paper ready. When ready to write, say "Go on."
(4.) Dictate three of four words of the message at a time, selecting the groups of words according to the sense of the message.	Write down the group of words, repeating them slowly as you write them. Be careful not to repeat the last word until you have finished writing it.
(5.) Spell out all names of persons and places and all words which are written in block capitals.	Write down all words spelt out to you in block capitals and after each word is written repeat the spelling.
(6.) Transmit figures thus: 10066 will be transmitted "Figures — one, double O, double six, ten thousand and sixty-six."	Write down the figures as you receive them "10066" repeat "Figures—one, double O, double six, ten thousand and sixty-six."
(7.) When the transmission of the message is completed say "Message ends."	Repeat the whole message.
(8.) When the message has been correctly repeated say "Correct," and if you have no other message to send say "Good-bye."	Say "Good-bye."

3. When words are spelt on the telephone, the signalling names of the letters (emma, toc, beer, &c.) should invariably be used.

4. Care should be taken not to shout into the telephone. The natural pitch of voice should be used, but talking should be clear and distinct and rather slow.

CHAPTER IV.

MILITARY ENGINEERING.

GLOSSARY OF TERMS.

Abatis.—An obstacle formed of trees or branches of trees picketed to the ground, with their points towards the enemy.

Banquette.—A bank upon which men stand to fire over a parapet.

Berm.—A small space left between the parapet and excavations of a work.

Bivouac.—An encampment without tents or huts.

Bomb-proof.—A shelter, proof against the penetration of shells.

Calibre.—The diameter of the bore of a gun.

Caponier.—A small chamber formed in the ditch of a work projecting from the escarp to give fire down the ditch.

Casemate.—A shell-proof chamber constructed for the accommodation of the garrison of a work or position.

Chess.—A plank forming a portion of the flooring of a bridge.

Command.—The vertical height of the crest of a work above the natural surface of the ground.

Counterscarp.—The slope of the ditch of a work furthest from the parapet.

Crest.—The intersection of the interior and superior slopes of a parapet.

Crib-pier.—A support for a bridge formed of layers of baulks of wood laid alternately at right angles to each other.

Dead Ground.—Ground which cannot be covered by the defenders' fire.

Defilade.—The adjustment of the levels of the crest and interior portions of a work with a view to obtain cover for the defenders or to screen them from view.

Derrick.—A single spar held up by four guys, used for lifting or moving weights.

Embrasure.—A channel through the parapet of a work through which a gun is fired.

Enfilade Fire.—Fire which sweeps a line of troops or defences from a flank.

Epaulment.—A small parapet to give cover to a gun and detachment in action.

Escarp.—The slope of a ditch nearest the parapet.

Exterior Slope.—The outside slope of a parapet extending downwards from the superior slope.

Fascine.—A long bundle of brushwood, tied up tightly, used for revetting, &c.

Flèche.—A work consisting of two faces, forming a salient angle towards the enemy.

Fougasse.—A small mine filled with stones which are projected towards the enemy on the mine being fired.

Fraise.—A palisade fixed horizontally in a slope.

Gabion.—An open cylinder of brushwood, sheet iron, &c., used for revetting.

Glacis.—The ground round a work outside the ditch. This is sometimes made up artificially.

Gorge.—The face of a work furthest from the enemy.

Guy.—A rope fastened to the tip of a spar or frame, to support, raise, or lower it.

Gyn.—A tripod constructed with three spars, used for raising weights.

Interior Slope.—The inside slope of a parapet (seen in section), extending from the crest to the banquette.

Keep or Réduit.—A separate enclosure within another work to enable the defenders to resist after the outer line of defence has been carried.

Lunette.—A work consisting of four faces, the two centre ones forming an obtuse salient, the two side ones affording fire to the flanks.

Lunette, blunted.—A work, consisting of five faces (otherwise similar to a lunette).

Machicoulis Gallery.—A balcony with a musket-proof parapet in front, loopholed in the floor, to afford fire in a downward direction.

Parados.—A traverse to give cover from reverse fire.

Profile.—The section of a parapet at right angles to the crest.

Redan.—A work consisting of two faces, forming a salient angle towards the enemy.

Redan, blunted.—A work consisting of three faces, the centre one firing to the front, the others to the flanks.

Redoubt.—A field work entirely enclosed by a defensible parapet.

Relief.—The length of time that men have to work before being relieved.

Revetment.—Any method of making earth stand at a steeper slope than the natural slope.

Reverse Fire.—Fire directed on the backs of a line of defenders.

Riband.—A baulk fastened down on each side of a roadway to keep the chesses in place.

Sap.—A trench formed by constantly extending the end.

Sheers.—Two spars lashed together at the tip and raised to rest on their butts, which are separated. They are used to lift and move weights in one plane.

Splinter-proof.—A shelter, proof against splinters of shell.

Superior Slope.—The top of a parapet (seen in section).

Tackle.—Any system of blocks and ropes by which power is gained at the expense of time (*i.e.*, more power—less speed)

Tambour.—A projecting chamber or stockaded enclosure, constructed so as to flank the walls of a building.

Terreplein.—The surface of the ground inside a work.

Trace.—The outline of a work in plan.

Traverse.—A bank of earth erected to give cover against enfilade fire, and to localise the bursts of shells.

Wattle.—Continuous brushwood hurdle-work.

FIELD WORKS.—GENERAL.

The heights over which an average man can fire on level ground are :—

	Ft.	in.		
Lying down	1	0		
Kneeling	3	0	Ft.	in.
Standing	4	3 to 4	6	

These heights must be adjusted to suit different men and varying inclinations of ground.

Rifle-fire.

Modern military rifles are sighted to about 2,800 yards. The slope of descent of the bullet varies from about $\frac{1}{30}$ at 1,000 yards to $\frac{1}{2 \cdot 5}$ at 2,800 yards.

Proof Thickness.

The following table gives the thickness in various materials proof against modern rifle-bullets at point-blank range :—

Material.	Thickness proof.	Remarks.
Clay	5 ft.	Varies greatly. This is maximum for greasy clay.
Earth, free from stones (unrammed)	3 ft.	Ramming earth reduces its resisting-power.
Sand	2 ft. 6 in.	Rather more than enough. Very high velocity bullets have less penetration in sand at short than at medium ranges.
Sand between boards	18 in.	
Brickwork	9 in.	If well built.
Soft wood — *e.g.*, fir, across grain	48 in.	24 in. proof at 500 yards.
Hard wood—*e.g.*, oak, across grain	27 in.	15 in. proof at 500 yards.
Wrought iron or mild steel	$\frac{1}{2}$ in.	
Hardened steel plate	$\frac{1}{4}$ in.	$\frac{1}{10}$ in. proof at 500 yards.
Special hard steel ..	$\frac{1}{5}$ in.	
Shingle	6 in.	
Coal	15 in.	
Snow	About 8 ft.	

Field Artillery.

The usual projectiles for field artillery are shrapnel from field-guns, and shrapnel and common shell filled with high explosive from field-howitzers.

Shrapnel can be used from field-guns at ranges up to about 6,000 yards.

The slope of descent of the projectiles of field-guns varies from $\frac{1}{20}$ at 1,500 yards to $\frac{1}{4}$ at 4,000 yards, but howitzer projectiles have angles of descent up to $\frac{1}{1}$.

Ranges of Weapons.

The following table (taken from "Combined Training," 1905) gives the various ranges of the different weapons :—

Terms applied to Ranges.	Rifle.	Field Artillery.	Heavy Artillery.
	Yards.	Yards.	Yards.
Distant ..	2,800–2,000	6,000–4,500	10,000–6,000
Long	2,000–1,400	4,500–3,500	6,000–4,000
Effective ..	1,400–600	3,500–2,000	4,000–2,500
Decisive ..	600 and under.	2,000 and under.	2,500 and under.

The extreme width of the area of ground struck by the bullets of an effective shrapnel is about 25 yards.

The limit of the forward effect of shrapnel at effective range is about 300 yards.

The radius of the explosion of a high explosive shell is about 25 yards.

The following terms are used with reference to artillery and rifle fire :—

Natures of Fire.

High-angle Fire.—Fire from guns and howitzers at all angles of elevation exceeding 25°.

Frontal Fire.—When the line of fire is perpendicular to the front of the target.

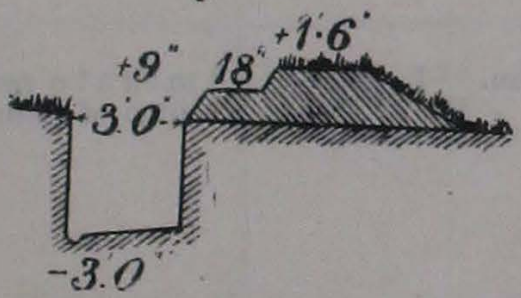
Oblique Fire.—When the line of fire is inclined to the front of the target.

Enfilade Fire.—Fire which sweeps a line of troops or defences from a flank.

Reverse Fire.—When the rear instead of the front of the target is fired at.

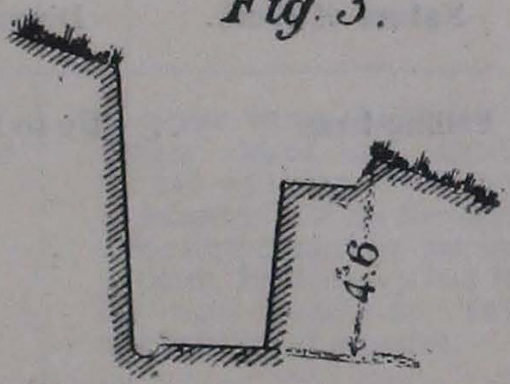
TYPES OF FIRE TRENCHES.

Fig. 1.



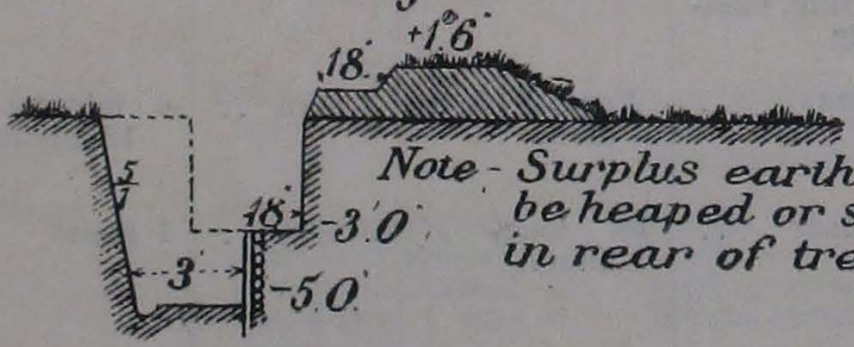
2paces takes untrained man 1½ hrs.

Fig. 3.



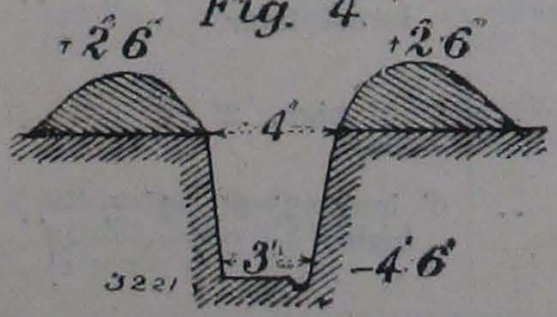
Earth spread about or used to form dummy parapet.

Fig. 2.



Note - Surplus earth may be heaped or spread in rear of trench

Fig. 4



CUNICATION TRENCH.

WORKING-

Nature of Work.	Dimensions.	No. of Men.	Time.
1. Felling trees ..	Up to 1′ diam.	1 man ..	1 minute per inch of diam.
2. Cutting brushwood ..	Up to about 1½″ diam.	,, ..	4 hours ..
3. Clearing plantation of brushwood, with trees up to 12 in. diam.; sorting, binding, carting	100 yd. by 40 yd.	1 company (100 men)	,, ..
4. Cutting hedge ..	Wood, ½″ to 2″ diam.	1 man ..	6 minutes to 18 minutes
5. Making fascines ..	18′ long, 9″ diam.	5 men ..	1 hour ..
6. Gabions	2′ 9″ high, 2′ external diam.	3 ;; ..	2 hours ..
7. Band gabions ..	2′ 9″ high, 2′ diam.	2 ;; ..	10 minutes ..
8. Hurdles	6′ long, 2′ 9″ high	3 ;; ..	2½ hours ..

PARTY TABLE.

Amount.	Tools.	Remarks.
..	Felling-axes; hand-axes; saws, cross-cut; saws, hand	For larger trees, the diam. in inches cubed and divided by 144 will give the number of minutes. With the hand-axe allow 2 minutes per inch of diam. for trees up to 1 ft.; for trees over 1 ft., twice the calculated amount.
100 sq. yd. or 9 to 10 bundles of 50 lb. each	Bill-hooks; lashing or wire; a small portion of felling-axes, hand-axes, and saws; a grindstone and a few whet-stones	Men opened at 4 yd. interval should cut 25 yd. to their front in 4 hours.
About 300 bundles of 50 lb. each		40 men cutting; 40 men sorting and binding; 20 men carting.
2 paces	Bill-hooks and hand-axes	If very bushy, a pole and ropes can be used to expose their lower branches to the axe.
1	1 measuring-rod, 1 choker, 3 bill-hooks, 2 knives, 1 maul, 1 hand-saw, 1 pair of pliers	Materials: 4 bundles brush-wood, 60 ft. of wire or spun yarn if withes are not used. Weight about 140 lb.
1	1 bill-hook, 1 mallet, 2 knives, 1 measuring-rod	One and a half bundles of brushwood. Weight complete, about 50 lb.
1	..	10 bands, 10 pickets. Weight complete, 13 lb.
1	2 bill-hooks, 2 knives, 1 mallet, 1 pair of pliers (if sewn with wire)	

WORKING-

Nature of work.	Dimensions.	No. of Men.	Time.
9. Cutting sods ..	18″ x 9″ x 4½″	3 men ..	1 hour ..
10. Loophole in wall, two bricks thick	..	1 man ..	½ ,, ..
11. Notch, two bricks thick	..	,, ..	10 minutes ..
12. Abatis, roughly constructed ..	50 yd. deep ..	,, ..	1 relief ..
13. Low wire entanglement	..	10 men ..	1 hour ..
14. High wire entanglement	..	5 ,, ..	4 hours ..

N.B.—Gabion revetments, 7′ 6″ high, requires 14 gabions, 3 fascines
Hurdles or brushwood, 2′ 9″ high, requires 9 bundles brush-
Sandbag revetment requires 200 sandbags per 100 sup. ft.
For constructing head-cover, sandbags and sods on earth

PARTY TABLE—*continued.*

Amount.	Tools.	Remarks.
100	Sharpened spades or sod-cutter	
..	Crowbar or pick	
1	,,	
2 paces	..	Trees used where felled.
100 sq. yd.	3 bill-hooks, 1 maul, 2 pairs of pilers	1 sq. ft. of entanglement takes 1 ft. of wire.
20 yd. length	2 bill-hooks, 2 mauls, 2 pairs of pliers, 1 hand-saw	1 sq. ft. takes 3 ft. of wire. Entanglement built with 3 rows of pickets, each 2 yd. apart.

per 100 sup. ft.
wood, wire and stakes for anchoring per 100 sup. ft.

parapets, allow ½ hour to 1 hour in addition to the calculated task,

EARTHWORKS.

Earthworks for field-work consist of trenches and redoubts.

Important Points for Trenches.

1. Good field of fire. Flanking fire to be considered. Do not give cover at expense of fire-effect.
2. Concealment particularly from the enemy's artillery.
3. Invisibility.
4. Cover for reserves, natural if possible.
5. Expose enemy's movements, conceal your own.
6. Bullet-proof parapet.
7. Overhead cover if possible.
8. Protection from enfilade fire.
9. Steep interior slope.
10. Trench wide enough at bottom to admit of easy circulation.
11. Simplicity of construction and arrangement.
12. Mislead the enemy.
13. Drainage.

Redoubts are used principally for isolated positions, posts on L. of C., or advanced posts.

Trenches.

Trenches are distinguished as "fire trenches" and "cover trenches," according as they are for the firing-line or merely to cover troops not actually engaged.

Fire Trenches.

The design of the trench will depend on the time and labour available on the soil, and on the siting, but the following points are important :—

1. The parapet should be bullet-proof at the top—2 ft. 6 in. to 3 ft. will usually suffice.
2. The trench should be as invisible as possible.

3. The interior slope should be as steep as possible.

4. The bottom of the trench (unless there is a step) should be wide enough to allow men to sit in it.

5. The interior should be protected, as far as possible, against oblique and enfilade fire, and sometimes from reverse fire.

6. Drainage should be attended to.

Siting of Trenches.

(See also "Combined Training," 1905, Section 126.)

The following points must be considered :—

A good field of fire. This is most important, and should not be sacrificed to any other consideration.

As much concealment as possible, particularly from the enemy's artillery.

Ground in rear suitable for reserves.

When the position includes commanding ground the firing-line need not necessarily be on it ; it should be in the best position for fire-effect. It will often be a good plan to place the firing-line at or near the foot of a slope, so as to obtain a grazing-fire, with the artillery on the high ground above.

The advantage of high ground for a defensive position is often overestimated. It need only be high enough to conceal and shelter the defenders' reserves and their movements, and to expose the movements of the enemy.

Arrangement of Trenches.

The arrangement of trenches should be simple. There should be one main line of defence. Several tiers of trenches may sometimes be useful, to increase the volume of defenders' fire, and also to deceive the attack as to the actual position of the defence ; but there should be no idea of using these trenches as successive lines of defence. The defenders should understand clearly which is the main line of defence, and

what it is that they must hold on to when the assault is pushed home.

The main line should not, as a rule, be continuous. If echelonned in suitable lengths, say, for companies, or even smaller units, it will be more difficult for the enemy's artillery to get the range.

In tracing a trench attention should be paid to probable enfilade fire.

Every artifice should be used to mislead the enemy as to the positions of the trenches—*e.g.*, conspicuous dummy trenches to draw his fire.

OBSTACLES.

Obstacles should be,—

1. Under the close fire of the defenders by day and night.
2. Difficult to remove or destroy.
3. In positions unknown to the enemy.
4. Arranged so as not to impede counter-attacks.
5. Illuminated at night if possible.

They are, among others: Abatis, tree entanglement, wire entanglements low and high, palisades, fraises, barricades, fougasses, land mines, inundations. For details of obstacles, time and material required, see Working-party Table, pp. 78–81.

Tools required for party removing obstacles: Hand-saws, axes, bill-hooks, wire-cutters, ropes and grapnels, gun-cotton or other explosives.

Roads.

Temporary communications by road are usually required—

(*a.*) In connection with a defensive position, to enable troops to be readily moved from one portion to another.

(*b.*) For the movement across country of detached columns.

The points to be kept in mind are: That troops should be able to move on as broad a front as possible, and that troops and messengers should be guided to their destination by sign-posts, by "blazing" trees or other means.

The best foundation for a temporary road over boggy ground is a layer or layers of fascines placed touching one another; the top row must lie across the direction of the traffic, but when time is not available or suitable material not at hand much can be done by throwing down brushwood, heather, or even straw or grass, care being taken that this, like the fascines, is laid across the road.

If there is much wheeled transport, a reserve of material should be collected to replace any that gets worn through.

Corduroy roads may also be made. Fell trees, bind together, and lay across road. Fill interstices with rubble, small stones, &c.

Roads can be made also with hurdles, fascines, or planks.

A trench should be dug on both sides of the road for draining purposes.

Roadway 10 ft. wide (8 ft. minimum) will take a single line of wagons passing in one direction, or infantry in fours. For each additional line of vehicles 10 ft. should be added.

Six feet is sufficient for infantry in file or for pack animals moving in one direction.

Gradients.

For short distance, may be $\frac{1}{3}$ or $\frac{1}{2}$ for infantry.

" " $\frac{1}{7}$ for artillery.

" " $\frac{1}{10}$ for animals.

Steeper than $\frac{1}{10}$ is inconvenient for animals or wheeled traffic.

Traction-engines.

Draw their own weight up $\frac{1}{10}$.

Twice their weight up $\frac{1}{20}$.

Three times their weight on the level or slopes not exceeding $\frac{1}{33}$.

DEFENCE OF POSTS AND VILLAGES AND OUTPOSTS.

Points to remember.

Posts.

1. Organization of outer and inner defences.
2. Defenders to be close to the ground they have to defend.
3. Storage of ammunition, water, and supplies, strong obstacles, automatic alarms.
4. Clear field of fire, adequate cover, good communications, telephones, telegraphs, or signalling.

Villages.

1. Clear field of fire, and make obstacles.
2. Provide or improve cover for firing-line and supports along garden enclosures, &c.
3. Decide what houses lend themselves to defence of village, and prepare them accordingly; consider the desirability of a keep.
4. Do not forget communications.

Note.—In 1 and 2 above the extent of the line of defence must be proportional to the available garrison. Sanitary measures must be taken.

Outposts.

1. Entrench when possible.
2. Provide a good field of fire.
3. Protect from enfilade or reverse fire.

Detonator.

A detonator is loaded with fulminate of mercury. No. 8 is that used with fuzes.

Tamp whenever possible. Increase charges by 50 per cent. in the presence of the enemy.

For charges, see Table.

Special Cases.

Brickwork.—Use gun-cotton.

Bridges, Thin Piers, and Walls.—Lay the charge on a board against the wall or pier, or else cut groove ; fill it with gun-cotton ; tamp.

Thick Piers, Attack Haunches—i.e., *Sides of Arch.*—Dig trench to back of arch-ring at each haunch. When there is no time for the haunches, attack the crown.

Girder Bridges.—Cut top and bottom flanges. Bottom most important. Easiest to cut near point of support.

Houses and Huts.—Weakly built houses : Put charge in centre of room, shut doors and windows. 6 lb. to 12 lb. gun-cotton would destroy four-roomed cottage. Mud huts, up to 18 ft. square with walls 2 ft. thick, require 4 lb. gun-cotton. Towers of stone and mud, walls 3 ft. thick, 15 ft. side, 16 lb. gun-cotton ; 25 ft. side, 24 lb. gun-cotton.

Timber.—Use primers ; make holes, or put on a necklace.

Stockade.—Put charge on a board against the stockade.

Railways.—Attack the bridges. In iron and steel bridges cut the girders.

Tunnels.—Attack the crown or the haunches.

Guns.—Put in a shell, add a charge of gun-cotton in the chamber, tamp, close the breech-block as far as possible.

For a 3 in. gun use 2 lb. of gun-cotton, double the charge for every inch increase in calibre—*i.e.*, for 4 in. guns, use 4 lb. ; for 5 in., 8 lb., &c. A shell is not absolutely necessary

In all gun-cotton demolitions see that the slabs are in close contact with each other and with the object to be cut; that the primer is in close contact with the slab, and the detonator with the primer.

DEMOLITION FORMULÆ.

Charges for Hasty Demolitions.

Note.—The charge is in pounds. B = length to be demolished in feet; T = thickness to be demolished in feet; t = thickness to be demolished in inches (in the case of iron plate only). In the presence of the enemy, increase the charges by 50 per cent.

Gunpowder (Tamped).

Object attacked.	Lb.	Remarks.
Brick arch—one haunch	$\frac{3}{2}BT^2$	Total amount divided into charges placed apart about twice the thickness of brickwork.
Brick arch—crown ..	$\frac{3}{2}BT^2$	
Brick wall	$\frac{3}{2}BT^2$	
Wood stockade — hard wood	40 to 100	One charge. Soft wood half this.
Stockade of earth between timber up to 3 ft. 6 in. thick	60 to 80 per 5 ft.	One charge.
Fort gate	200	One charge.
Tunnels	$\frac{2}{3}T^3$	Where T = total distance from the surface of the lining to the charge.

Gun-cotton (Untamped).

(If the charge is tamped, decrease by one-half.)

Object attacked.	Lb.	Remarks.
Brick arch—haunch or crown	$\frac{3}{4}BT^2$	Continuous charges.
Brick wall—up to 2 ft. thick	2 per ft.	Length of breech B not to be less than the height of the wall to be brought down.
Brick wall—over 2 ft. thick	$\frac{1}{2}BT^2$	
Brick pier	$\frac{2}{3}BT^2$	
Hard wood — stockade or single	$3BT^2$	In a single charge outside. For a round timber charge $= 3T^3$. (Soft wood; half this.)
Hard wood—necklace ..	$3BT^2$	Trees up to 12 in. diameter. For a round timber charge $= 3T^3$. (Soft wood; half this.)
Hard wood—auger-hole ..	$\frac{3}{8}T^2$	Where the timber is not round, T = smaller axis. (Soft wood; half this.)
Stockade of earth between timber up to 3 ft. 6 in. thick	4 per ft.	Single charge.
Heavy rail stockade ..	7 per ft.	
Fort gate	50	
Breech-loading gun ..	..	For 3 in. gun use 2 lb. Double the charge for every inch increase in calibre. To be placed in breech. The gun should be loaded with a shell if possible.
First-class rail	..	A third of a $1\frac{3}{4}$ lb. slab against the web near a chair if those are used.
Iron plate	$\frac{3}{2}Bt^2$	t is in inches.
Iron girders	$\frac{3}{2}Bt^2$	Calculate as for iron plate, given thickness of flange to be measured where it joins the web.
Frontier tower, stone and mud	16 to 30	In one charge in centre of tower.
Wire cable	$\left\{\frac{C^2}{24}\right\}$	C being the circumference in inches.

Without Explosives.

Railways.—Destroy the permanent-way or remove portions or tear up and twist rails. Destroy signals, bridges, tunnels, cuttings, &c., water-supply, workshops, and apparatus.

Locomotives.—To disable temporarily, take off injector, connecting-rods, piston, or safety-valve.

Carriages and Rolling-stock.—Remove springs or cut axels.

Telegraphs.—Destroy insulators, cut poles, establish false circuits, make disconnections, leaks, or contacts.

Subterranean Telegraphs.—Look for pipes (generally shown by marks), cut wire to pieces, remove your traces.

Guns.—Smash block and screw threads, or close the breech, then withdraw the hand-lever about 1 in., and with a handspike or rammer, beat down the lever until its hinge-joint is distorted. A few shots from a rifle fired at the carrier would jam up the mechanism still further.

Q.F. Ammunition.—If time, remove primers. If not, dent cases by hitting them with a hammer or crowbar.

Fuzes.

Safety-fuze.

The present pattern of safety-fuze is known as "Safety, No. 9."

This consists of a train of fine gunpowder enclosed in jute yarn, covered with guttapercha and waterproof tape. It is packed in tin cylinders containing 8, 24, or 50 fathoms.

It is coloured black.

Safety-fuze will burn under water.

For practical work the rate of burning can be taken as 3 ft. to 4 ft. per minute.

Old fuze should have its rate of burning tested before being used. Fuze which has been more than six months or so in a tropical climate should be very carefully examined.

It is difficult to light safety-fuze with a match or flame. A portfire or vesuvian (fusee) is best, but in the absence of such

means of ignition the head of a match inserted in the fuze and lit by another match forms a good method of lighting. A glowing cigar, cigarette, or pipe is also good for the purpose.

Instantaneous Fuze.

Consists of two strands of quick-match enclosed in flax and several layers of guttapercha and waterproof tape.

It burns at the rate of 30 yards a second, or practically instantaneously; it is packed in sealed tins holding 100 yards.

It is coloured orange.

It can be distinguished in the dark from safety-fuze by feeling the open crossed thread snaking outside it.

Joining Fuzes.

In firing charges with instantaneous fuze, a piece of safety-fuze should be joined on for lighting, in order to allow time for getting away, except in special cases where the instantaneous fuze used is long enough to admit of being lit from a safe place.

PRECAUTIONS.

When possible, tamp all charges. If gun-cotton charges are tamped one-half the charges given in the table are sufficient.

For demolitions in the presence of the enemy increase the calculated charges by 50 per cent.

Detonators should be buried to prevent being exploded by stray bullets.

When connecting up No. 8 detonators with fuze the detonating ends of the fuze should not be pointed at anybody.

When carried out under fire take every precaution against a possible failure; detail men to carry the stores to replace casualties, and see that every man with the party has the means of lighting the charge.

For large charges of all sorts which cannot easily be got at after tamping, and for demolition-work where certainty and

rapidity are essential, it is a good rule to insert two fuzes (and detonators if required) in the charge, in case one should prove faulty.

When pinching or bending the mouth of a detonator or cap to grip the fuze care should be taken not to squeeze the detonating end.

When tamping a gun-cotton charge with earth, stones, &c., the detonator should be protected from being knocked.

Make arrangements to prevent sparks from the fuze causing premature explosion of gunpowder charges, or setting fire to gun-cotton.

BRIDGES.

The most usual forms of bridges are—trestle, frame, suspension, cantilever, and floating.

Other methods are—cribwork, roadway on carts, trussed planks, and trussed logs.

Lashed trestles are 2-, 3-, and 4-legged. Trestles made up with spikes may have more legs.

Frame are single and double lock—single for spans up to 30 ft., double up to 45 ft.

Floating are made of boats, casks, or rafts, &c.

Material carried by Field Troops and Companies.

A field troop carries two collapsible boats, each 18 ft. 6 in. long, making one raft. A field company carries two pontoons, capable of constructing 15 yards of medium bridge; and two trestles and one bay of superstructure, capable of constructing 5 yards of medium bridge.

Width.

Bridges for wheeled military traffic should have a width of 8 ft. in the clear at least. The normal width is 9 ft.

For infantry in file, or cavalry in single file, 6 ft.

For infantry in single file, 1½ ft. to 3 ft.

Planks should be 1½ in. to 2 in. thick.

Strength.

A bridge that will carry infantry in fours crowded at a check will carry field-guns and 5 in. howitzers and most of the ordinary wagons that accompany an army in the field.

Timbers of bridges for carrying heavier weights—*e.g.*, guns of position—should be calculated.

Dimension of Spars.

The following approximate dimensions for spars of unselected timber are necessary for trestle and lock bridges for carrying infantry in fours crowded :—

For bays of 15 ft.—Road-bearing transoms, mean diameter 10 in. Baulks (six), mean diameter 7 in.

For bays of 12 ft.—1 in. less than above will suffice.

Other timbers not affected by length of bay :—

Ledger and handrails, mean diameter 4 in. to 6 in.

Braces and ribands, 3 in. at tip.

Legs, trestle, mean diameter 6 in.

Legs, single- and double-lock bridges, 7 in. at tip.

Frame transoms, single- and double-lock bridges, mean diameter 6 in.

Distance pieces, double-lock bridge, mean diameter 11 in.

These dimensions are calculated for spars of rather weak wood, such as larch, and allow for a factor of safety of three. Five road-bearers are enough for selected spars.

FORDS.

The following depths are fordable :—

For infantry, 3 ft.

For cavalry, 4 ft.

Wagons containing ammunition, 2 ft. 4 in.

Gravelly bottoms are best, sandy bottoms are bad, as the sand gets stirred up, and the depth of water thus increases.

Fords should be clearly marked by long pickets driven into the river-bed above and below the ford, their heads

being connected by a strong rope. It is well to mark the pickets, in order that any rise of the water may be at once evident.

The depth of a river is generally most uniform in straight parts; at bends the depth will generally be greater at the concave bank and less at the convex.

For this reason a river which is not anywhere fordable straight across may be found passable in a slanting direction between two bends; other means of passing a gap are flying bridges and ferries.

RAISING WEIGHTS.

Blocks are used for the purpose of changing the direction of ropes, or of gaining power.

They are called single, double, treble, &c., according to the number of sheaves, which are of metal or hard wood, and revolve on the pin, which should be kept well lubricated.

Snatch-blocks are single blocks with an opening in the shell and strap on one side, to admit a rope without passing its end through.

The rope with which tackles are rove is called a fall. To overhaul is to separate the blocks. To round in is to bring them closer together. When brought together the blocks are said to be chock.

Closed Vessels.

The buoyancy of closed vessels can be determined by the following methods:—

(*a.*) When the contents are known—

Multiply the contents, in gallons, by 10, and take $\frac{9}{10}$ of this, which will give safe buoyancy in pounds.

(*b.*) For casks, when the contents are not known—

Actual buoyancy $= 5C^2L - W$ lb.

Safe buoyancy $= \frac{9}{10}(5\,C^2L - W)$ lb.

Where C is the circumference of the cask, in feet, halfway between the bung and the extreme end; L is the extreme length, exclusive of projections along the curve, in feet; W is the weight of the barrels in pounds.

SUPPLY AND DISTRIBUTION OF WATER.

The first troops to arrive on a halting-ground will at once mount sentries on all water likely to be required for use, with orders to prevent any form of pollution.

These sentries will not be withdrawn until permanent water guards are detailed.

The selection and allotment of the water-supply is a duty of the general staff. Works connected with water-supply are an engineer service.

An advanced party composed of Royal Engineers, if any are available, will mark the water-supply with flags as follows:—

White for drinking-water.

Blue for watering-places for animals.

Red for washing or bathing-places.

Quantity required.

The minimum quantity of water in temperate climates required per day is—

Per man, for drinking ..	3 to 4 pints.
,, for drinking and cooking ..	3 to 4 quarts.
,, for all purposes ..	3 to 4 gallons.
,, per permanent hospital	40 gallons.

Horses drink about 2 gallons at a time, and take about five minutes to drink, including time for coming and going.

Per horse, mule, or ox, for drinking	6 to 8 gallons.
Per horse, mule, or ox, for cleaning (which may be salt) ..	6 to 8 quarts.
Per sheep or pig, for drinking	6 to 8 pints.

In tropical countries these amounts should, if possible, be doubled.

[1 gallon = 10 lb. 1 cubic foot = $6\frac{1}{4}$ gals. = $62\frac{1}{2}$ lb.]

Gauging the Supply.

It is sometimes possible to arrange for the collection of rain-water; but owing to evaporation, absorption by vegetable life, infiltration, &c., not more than about one-third of the rain is available for storage, on an average. On this assumption each square yard of catchment-area may be expected to produce 3 gallons per inch of rainfall.

Wells.

The supply of water obtainable from a well can be gauged by pumping to lower the level in the well, and then noting how long it takes to get a given quantity of water in.

Streams.

The rough average yield of a stream may be measured as follows: Select some 12 or 15 yards of stream where the channel is fairly uniform and there are no eddies. Take the breadth and average depth in feet, in three or four places. Drop in a chip of wood, and find the time it takes to travel, say, 30 ft. Thus obtain the surface-velocity per second in feet. Four-fifths of this will give the mean velocity, and this multiplied by the sectional area will give the yield per second in cubic feet of water.

A more accurate result can be got by damming up the stream, so that it is nearly at rest behind the dam, and flows away through a notch in a board. The notch may be rectangular or triangular, with sides at 90°, and must have its edges thinned. The height must be measured from the bottom of the notch to the surface of the water where it is not affected by the overfall. The amount of water flowing over a triangular notch will then be as in the following table:—

GALLONS PER HOUR FLOWING THBOUGH TRIANGULAR NOTCH.

Height in Inches.	Decimals of an Inch.									
	0·0.	0·1.	0·2.	0·3.	0·4.	0·5.	0·6.	0·7.	0·8.	0·9.
0 ..	0·0	0·36	2·1	5·7	12	21	33	48	68	91
1 ..	120	151	187	228	275	325	385	445	510	590
2 ..	670	760	850	950	1060	1170	1290	1400	1550	1700
3 ..	1850	2010	2180	2340	2530	2720	2920	3130	3340	3560

This table is calculated from the following formula, which is given in Molesworth's pocket-book: Discharge in gallons per minute $= 1{\cdot}978\ h^2\sqrt{h}$, where h = height above bottom of notch in inches.

In reporting on a water-supply an effort should be made to ascertain how far the supply is permanent, and at what seasons the variations take place.

SEARCH FOR SUBSOIL WATER.

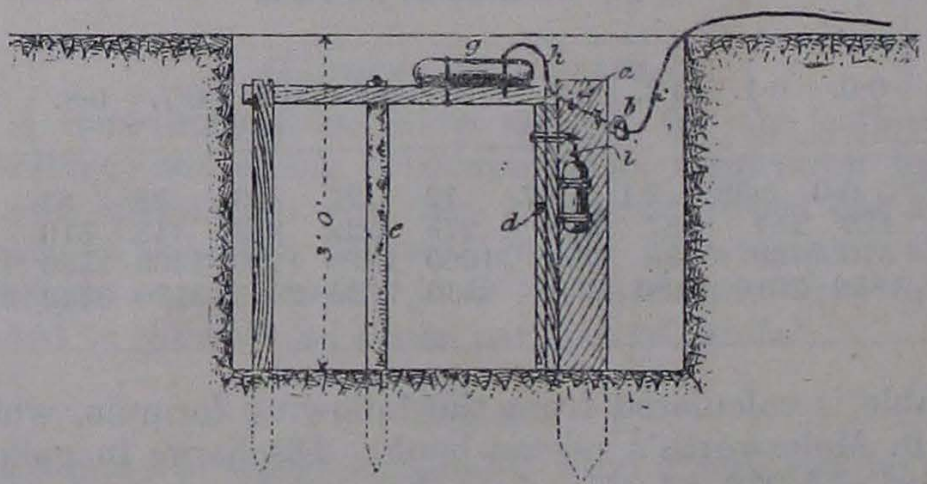
When the supply from visible sources is too impure or too small in quantity, search must be made for subsoil water, either by digging, or by driving tube wells. The latter are most useful, as they can be quickly driven, and in case of no water being found, taken up and driven again elsewhere.

SURFACE WELLS.

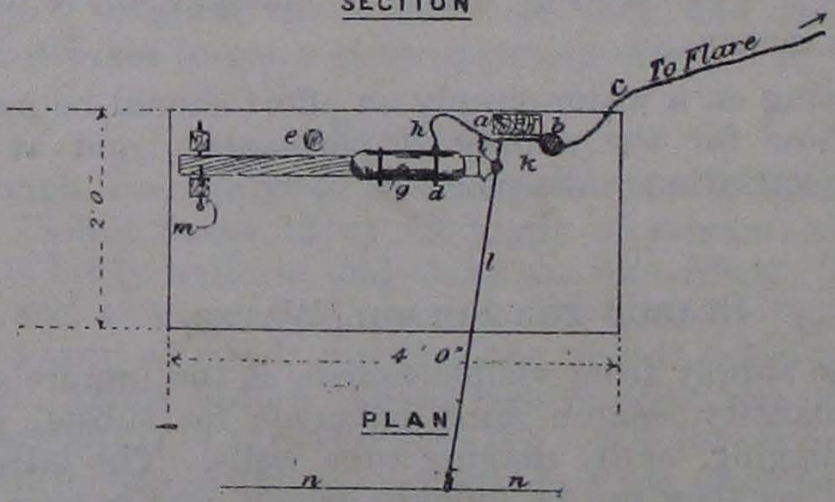
Springs near the surface may be sought for in depressions below the general level; where the earth is moist, or the grass unusually green; where birds or animals have lately been scratching, or where gnats hover in swarms.

AUTOMATIC FLARES.

FLARE PIT.



SECTION



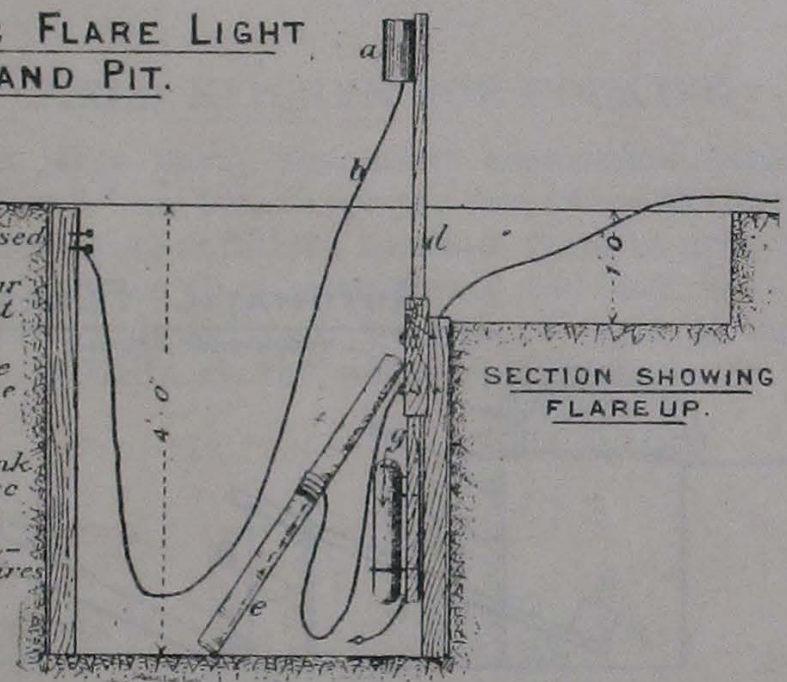
PLAN

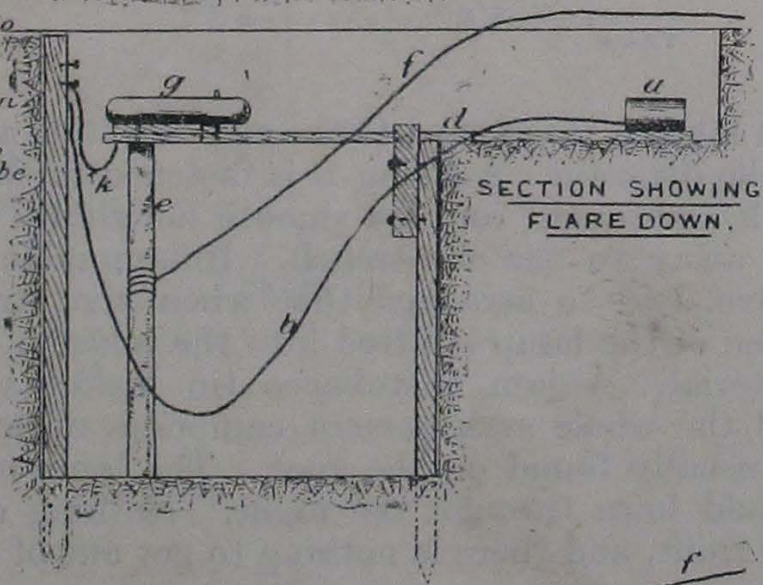
REFERENCE.

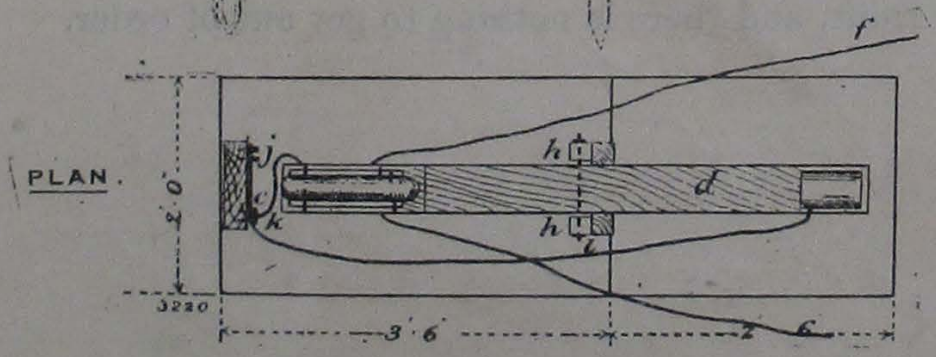
a Friction tube placed so that pull comes at a right angle.
b Quick match.
c Instantaneous fuze to flare.
d Prop stick.
e Guide stake.
f Pivotted arm 2'6" x 2"x 2"
g Weight attached to arm and connected by flexible wire or spun yarn to Friction tube.
h Flexible wire or spun yarn.
i Flexible wire or spun yarn from prop stick to weight
k Weight connected by flexible wire or spun yarn to prop stick and thence to wire "l"
l Wire connected to "cut of "trip" wire
m Wire pin thro' two uprights. and acting as pivot for arm on which weight "g" rests
n "Cut" or "trip" wire.

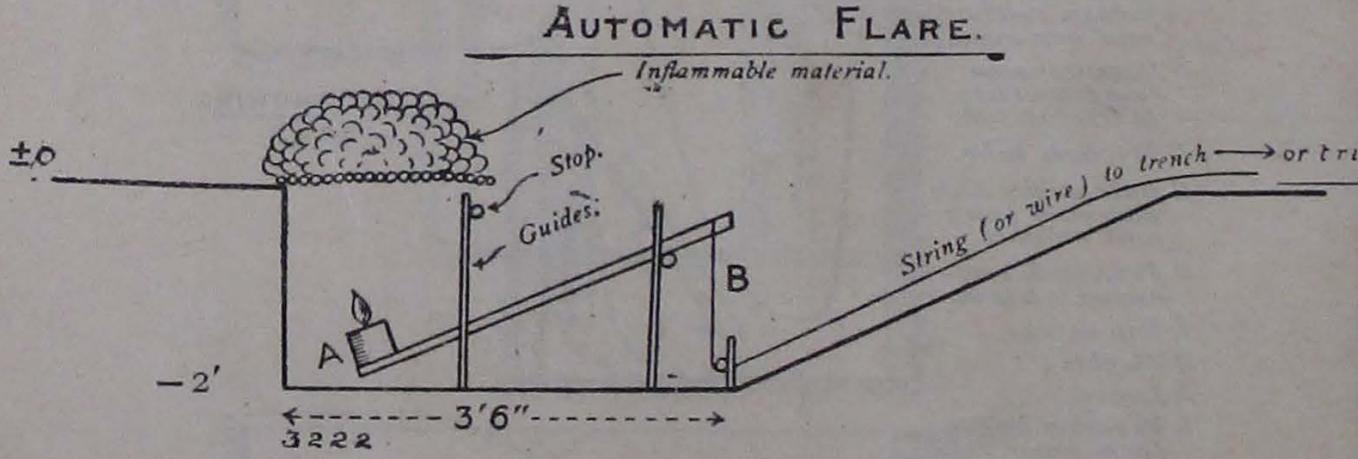
AUTOMATIC FLARE LIGHT AND PIT.

a. Flare, composed of nitrate of potash sulphur and orpiment.
b Instantaneous fuze from flare to friction tube.
C Friction tube
d Balanced plank carrying flare and weights.
e. Prop stick connected to trip wires
f Trip wires.
g Weights.
h Lugs.
i. ⅜ round bolt to form hinge.
j Quick match around friction tube.
k Pliable wire to fire friction tube.





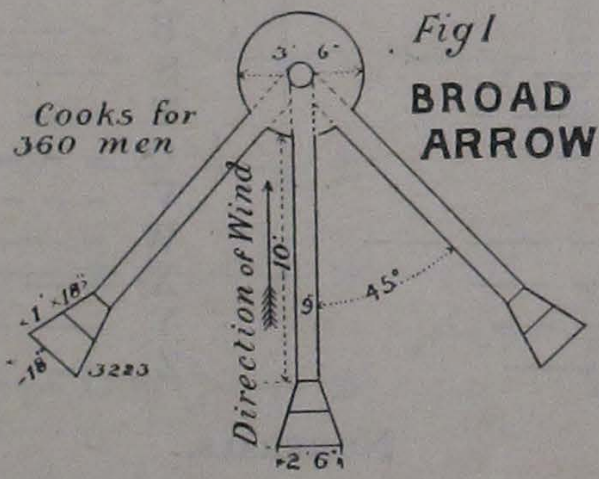




A lamp A is fastened to the end of a stick arranged as shown in the diagram. A string B is fastened to the other end of the stick, is brought round a smooth horizontal piece, and thence led away to the fire-trench. Inflammable material is laid above, and so arranged that when the string is pulled the flame of the lamp is lifted into the midst of this inflammable material. A jam or tobacco tin makes a first-class lamp, and the whole arrangement comprises nothing which cannot be usually found on the spot. The lamp is lit at dusk, and should burn through the night. Nothing can be seen from the front, and there is nothing to get out of order.

TYPE OF FIELD KITCHEN FOR COOKING.

To cook for a large party the most economical method is to dig or build up a long trench for the fire, place the kettles on it (its width not being sufficient to allow them to drop into it), and cover up between them with stones and clay, that the fire, fed from the windward end, may draw right through. A chimney can be built at the other end to increase the draught.



CHAPTER IV.

SIGNALLING.

MORSE ALPHABET.

A	·—	N	—·
B	—···	O	———
C	—·—·	P	·——·
D	—··	Q	——·—
E	·	R	·—·
F	··—·	S	···
G	——·	T	—
H	····	U	··—
I	··	V	···—
J	·———	W	·——
K	—·—	X	—··—
L	·—··	Y	—·——
M	——	Z	——··

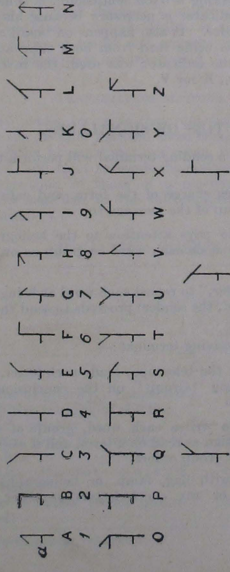
Numerals.

1	·————	6	—····
2	··———	7	——···
3	···——	8	———··
4	····—	9	————·
5	·····	0	—————

Long Numerals.

1	·——— ——— ——— ———	6	—····
2	··——— ——— ———	7	——···
3	···—— ———	8	———··
4	····— ———	9	————·
5	·····	0	—————

SEMAPHORE ALPHABET, NUMERALS AND SPECIAL SIGNS.



NUMERAL SIGN (FIGURES FOLLOW).

ANNUL.

ALPHABETICAL SIGN (LETTERS FOLLOW).

The small arm at *a* is called the "indicator," and shows the side from which the alphabet or signs commence; the signaller, when working a fixed sempahore, is sometimes not visible, and the indicator is necessary because his back may be towards the reader. It also happens on board ship that a semaphore signal is being read from both sides at the same time, and unless the indicator was used, the reverse letters might be read—*e.g.*, K for V.

DUTIES OF SIGNALLERS.

The signallers at a sending terminal will perform the following duties :—

"Caller" takes charge of the form, and calls out each word or group of the message to

"Sender" who pays attention to the heliograph lamp or flag, and sends each word or group as ordered, but waits for

"Answer Reader," to report each word as being answered before he (*i.e.*, the sender) proceeds to send the next.

Similarly at a receiving terminal :—

"Reader" (at the telescope) reads each letter, numeral, or sign, saying "Group" on the conclusion of each word, &c., to

"Writer," who writes each word, group of numerals, numeral, or sign as read on a form, and if satisfied with each word or group orders

"Answerer" (with flag, lamp, or heliograph) to send the answer or any check letters or other signs as required.

When less than three men are employed some of the above duties must be combined as may be found most convenient. For example, at short distance a sender or caller can read answers in addition to his own duties, or again at a receiving station the duties of reader and answerer may be combined, provided the telescope is not being used.

Transmitting-stations.

When two places, owing to their not being visible to one another, or the distance between them being too great, cannot be connected by terminal stations alone, intermediate points are occupied, and form transmitting-stations. As the duties are a combination of those of a receiving and a sending terminal, six men will be the full complement for a transmitting-station.

SIGNALLING PREFIXES.

Class.	Prefix.	
	For Delivery.	For Transmission.
i. Clear line or priority. Connected with the working of the line	SG	XG
ii. O.H.M.S., priority	SB	XB
iii. Connected with the working of the line	SG	XG
iv. O.H.M.S., if not marked "Priority"	SM	XM
v. Private or Press (when authorised)	S	X

OXYGEN GAS, AND METHOD OF MAKING IT.

The oxygen gas is obtained from a mixture in the following proportion, viz.:—

Chlorate of potash	3
Granulated binoxide of manganese ..	1

It may be prepared from chlorate of potash alone, but the binoxide of manganese is added so that the gas may be given off from the mixture at a lower temperature and with greater rapidity. The ingredients must be well mixed.

Put 2 lb., or a pint and a half, of the above mixture into the retort, which must be thoroughly clean and dry, and screw the cap and brass tube tightly home. (The gas from this quantity will fill two bags.) See that the wash-bottle, elastic tubing, and retort, are thoroughly clean, and that the safety-valve of the latter is working freely; the two former must be blown through to insure that all is clear, and the wash-bottle half filled with cold water.

Place the gas-bag with nozzle nearest the ground at a convenient distance from the fire on the windward side; open its tap, and connect it by means of the tubing to the opening in the wash-bottle marked "out." Then attach a separate piece to the one marked "in." Place the retort on a slow wood-fire (if it is made too fierce or a coal-fire used the retort will be damaged); carefully watch the retort whilst the gas is being made.

Shortly after it has been placed on the fire steam will be given off, and in six to ten minutes the gas will commence to

come, which can easily be distinguished from the steam by holding a piece of glowing wood to the tube of the retort, when a brilliant flame will be produced.

After this result has been obtained, connect the wash-bottle and retort by the tubing previously mentioned. The gas will now pass through the wash-bottle to the bag; if it comes too freely, which can be detected by a loud and continuous bubbling in the wash-bottle, the retort must be taken off the fire, put in a warm position near it, and replaced when necessary.

While the process of filling the bag is going on, if others are to be inflated they will be laid out flat, so that the tubing can be quickly transferred to them as required. When filled turn off the gas-bag tap.

After the gas is made, and the retort has been removed from the fire, the tubing connecting the wash-bottle and retort must be removed, or else as the mixture in the retort cools water from the wash-bottle might be sucked into the retort.

CODE TIME.

While precedence among different classes of messages is determined by the prefix, the order of transmission among messages of the same class and character must also be determined. For example, a central station may be in communication with several others, and receive two or more messages with the same prefixes for transmission along the same circuit. These must be despatched according to the priority of their code time.

MISCELLANEOUS

No.	Name.	Signal.	By which Station used.
1	General answer	——	Receiving ..
2	Preparative ..	– – – – – – – – &c.	Sending ..
3	Erase ..	– – – – – – – – &c.	,, ..
4	Clear line ..	OOO	Either ..
5	Obliterator ..	WW	Sending ..
6	Stop	Flag waved across the body; or, with light, by succession of dashes	Either ..
7	Figures intended	FI	Sending ..
8	,, finished	FF	,, ..
9	Block ..	Z	,, ..
10	Cipher ..	CC	,, ..
11	Full stop ..	iii A.A.A	,, ..

*When using the flag at extreme distances the

SIGNALS.

Purpose.	How sent.	How answered.
To acknowledge, a word or group not otherwise acknowledged	* As a group of 1 letter.	
To attract the attention of an unknown station	A succession of dots sent continuously	General answer.
(*a*) To erase a word or group sent incorrectly; (*b*) to erase a word or group incorrectly checked	A succession of dots and dashes sent continuously until answered	By the same signal.
To stop work at all stations preparatory to sending a very urgent message	As a group of 3 letters ..	,,
To cancel a message just sent or then being sent	,, 2 ,, ..	,,
To interrupt a message ..	Continuously until answered	,,
To indicate numerals about to be sent	As a group of 2 letters ..	General answer.
To indicate numerals finished, letters being resumed	,, 2 ,, ..	,,
Sent before and after a word or portion of a message written in capitals	,, 1 ,, ..	,,
Sent before and after cipher or a word or portion of a message to be repeated back	,, 2 ,, ..	,,
Alone, a mark of punctuation; with figures indicates decimal point or separates hours from minutes	Alone, as a group of 3 letters, or with figures, in the same group, but separated from them by a slight pause	General answer, or checked back with figures.

general answer may be made more than once.

MISCELLANEOUS

No.	Name.	Signal.	By which Station used.
12	Oblique stroke	sss SEMPH. — · · — MORSE	Sending ..
13	Word after ..	WA	(*a*) Receiving ..
14	,, before ..	WB	(*b*) Sending ..
15	Repeat ..	IMI	Receiving ..
16	Go on, or spell out	G	(*a*) Either .. (*b*) Receiving ..
17	Break ..	II SEMPH. — · · — MORSE	Sending ..
18	End of message	VE	,, ..
19	Message correct	RD	Receiving ..
20	Signaller's message	PP	Either ..
21	Naval and military sign	xxxx, &c.	Sending ..

SIGNALS—*continued.*

Purpose.	How sent.	How answered.
To separate figures, letters, &c., and as a mark of division	Sent in the same group as figures, or if none then with letters	Checked back with figures.
To ask for the repetition of a doubtful word	As a group of 2 letters ..	General answer.
To supply an omission ..	,, 2 ,, ..	,,
To ask for a particular portion of a message to be sent over again	,, 3 ,, ..	General answer.
To instruct the distant station to proceed with the work in hand To intimate that they wish the group in question or the next group sent in full	,, 1 ,, ..	General answer or complying.
To separate the text from the addresses of a message	,, 2 ,, ..	General answer.
To intimate that the message is concluded	,, 2 ,, ..	R.D. flag up or light exposed.
Sent after all necessary corrections, &c., have been obtained as an acknowledgment that the message has been correctly received	,, 2 ,, ..	General answer.
Sent previous to sending instructions to the distant station	,, 2 ,, ..	..
Vide Chap. ..	Sent as a succession of x's, continuously until answered	,,

This code time represents the hour at which the message was handed in by the sender at the telegraph-office of origin.

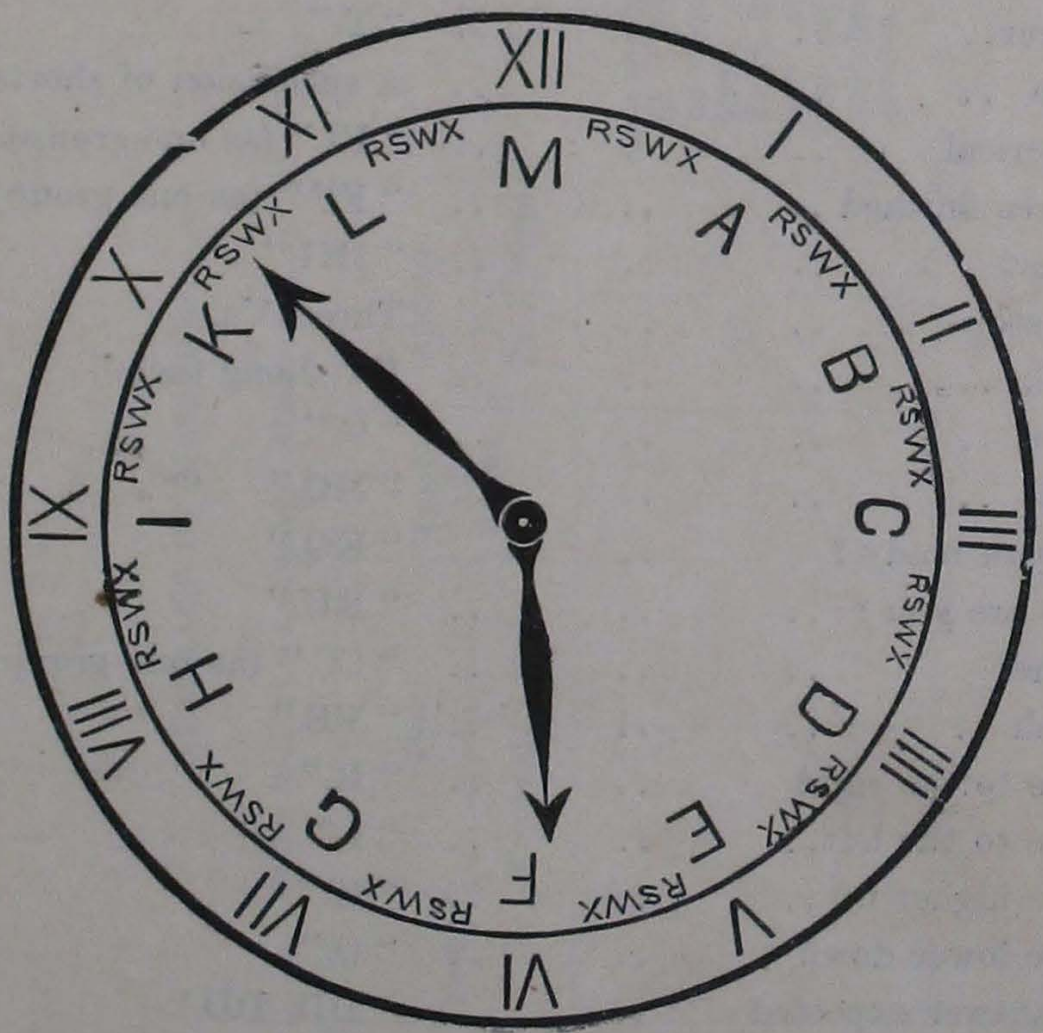
The twelve letters from A to M (J excepted) denote the twelve hours. They also denote the twelve periods of five minutes of which each hour is composed. The intervening four minutes are denoted by the letters R, S, W, X. The letters sent singly indicate the hours; sent in combinations of two they represent the hours and certain periods of five minutes; sent in connection with the intermediate letters R, S, W, X, they represent hours and minutes.

The letters A.M. or P.M. are signalled in conjunction with the code thus:—

M is 12.	B is 2.
F is 6.	I is 9.
M F is 12.30.	B I is 2.45.
M F S is 12.32.	B I X is 2.49.
M F S A.M. is 12.32 A.M.	B I X P.M. is 2.49 P.M.

In order to avoid difficulty of distinguishing between midnight and noon (both being represented by the letter M) messages are never "coded" M; but, if handed in either exactly at midnight or exactly at noon, they are coded M R A.M. or M R P.M. as the case may be.

or the time a visual signalling station accepts a message for transmission



MISCELLANEOUS MORSE SIGNS AND SIGNALS USED IN SIGNALLING BETWEEN NAVY AND ARMY.

The naval and military sign ..	A succession of X's.
Answer..	"T."
Erase	A succession of shorts.
Numerical	"FI" (as one group).
Figures finished	"FF" (as one group).
Repeat	"IMI."
Full stop	Three A's.
Break	II "Long tack."
Go on	"G."
Wait	"MQ."
Are you ready ?	"KQ."
Who are you ?	"RU."
Cypher	"CC" (as one group).
Finish	"VE."
Move to the right	"R."
Move to the left..	"L."
Move higher up	"H."
Move lower down	"O."
No answer expected	"DD, DD."
Send DD, DD messages	"NA."
Call for light	Succession of shorts, followed by a steady light. Obscured when satisfied.

ABSTRACT OF MESSAGES.

From.....(date) to.....(date). Station..... Call.....

Date.	No. of Message.	Prefix.	Time.		Number of Words.	Address.		Remarks.
			Received.	Sent.		To	From	
								The words "Clear line" or "Priority" should be entered opposite those messages to which they refer. Also how and by whom the message was despatched to the addressee.

Instruction.	Signal.	How answered.	Remarks.
(*a.*) To move the Signaller at the Distant Station Short Distances. (These Signals are made on the Assumption that the Stations are facing One Another.)			
1. Move to your right 2. Move to your left 3. Move higher up or further off 4. Move lower down or closer in	R L H O	By the general answer, then moving very slowly in the required direction (the flag being carried at the "Ready"), at the same time watching the distant station, and halting at once on seeing it make a dash or obscure its light	As soon as the station sending the signal sees the answer, it will hold the flag at the "Ready," or keep the light exposed, and watch the distant signaller moving; as soon as he reaches the desired position a dash will be made, or the light obscured. If the heliograph or lamp is being used it will be moved a short distance and reset, but in these cases time would probably be saved by sending fuller instructions.
(*b.*) Regarding Flags.			
5. Separate flags ..	SF	By the general answer, then moving and halting as above	Used when the waves of the distant station's flag cut those of another flag close to it, thus making it difficult to discern.

6. Use large blue flag	BF	By the general answer, then complying with the order.	
7. Use small blue flag	SBF		
8. Use large white flag	WF		
9. Use small white flag	SWF		
10. Use semaphore, white	SPW		
Use semaphore, blue	SPB		

(*c.*) Regarding Lamps and Heliographs.

11. Lengthen beat, or adjust your shutter	LB	By the general answer, then adjusting the shutter or beat	Signifies "Your light is not entirely obscured when it should be, owing to defective shutter of lamp or too short a beat on heliograph."
12. Open light ..	OL	By the general answer, then keeping the light steadily exposed or in the absence of sun holding the flag at the "Ready." When the distant light is satisfactory, the station will obscure their light, or make a dash meaning "Your light correct"	Used when a station wants a mark on which to set its light accurately. This may be necessary—(*a*) because the lamp or heliograph has been moved accidentally; (*b*) when changing from sighting-vane to duplex, or *vice versa*; (*c*) owing to being continually called for light, and it is therefore advisable to realign the instrument.
13. Turn off light ..	TOL	By the general answer, then turning away the mirror, or screening out the extra light	To signify (*a*) "The light is on this station when not required"—*e.g.*, if during a temporary cessation of work the shadow spot on the heliograph had gradually worked up; (*b*) "There is another light or fire in line with or close to you, which makes it difficult to read your lamp or heliograph."

STATION SIGNALS—*continued.*

Instruction.	Signal.	How answered.	Remarks.
14. Calling for light. When the distant station's light becomes too bad or indistinct to be read with ease, they will be called for light by a succession of dots followed by a steady exposure of light, or the flag held at the " Ready " ; on seeing this signal they will at once expose their own light, and slowly traverse the lamp or adjust the shadow-spot of the heliograph until the station making the demand obscure their light, intimating that they are satisfied ; the direction of the lamp or position of the shadow-spot will at once be noted, and care taken that these are not altered. If the call is maintained the alignment of the heliograph or state of the lime pencil, wick, &c., should be looked to. The sender should give all his attention to his lamp or heliograph, whilst the answer-reader must keep his eye on the distant station so that directly the light is obscured he can intimate the same to the sender by at once saying " Down "			The frequent use of this signal can only be necessitated—(*a*) by a faulty heliograph or lamp ; (*b*) by the sender not paying attention to his sighting-vane or lime-pencil, wick, &c. With young signallers there is a tendency to respond to a call for light by making a similar demand upon the distant station ; this habit should be checked, and they will be instructed to rectify their own light first, and then if necessary they may demand a better light from the distant station.
		(*d.*) MISCELLANEOUS.	
15. Who are you ? ..	RU	By the general answer, then sending their call, or if they have no call the name of the force, &c., to which they belong	If there is likely to be any doubt as to whether a party of signallers are friendly or hostile, a prearranged signal should be used in addition to the call.
16. Wait	MQ	By the general answer ..	Used for a temporary delay.
17. Are you ready ?..	KQ	,, ..	This is only to be used when there is reason to suppose the distant station is *not* ready.

18. Go on	G	By the general answer, then complying	Sent by a station that has sent MQ or has received KQ directly they are ready to resume work (*vide* page 114).
19. Send quicker ..	SQ	By the general answer	The rate should be increased or decreased by about two words a minute.
20. Send slower ..	SS		
21. No answer expected	*DD,DD	The receiving-station will acknowledge the receipt of the message or resume answering as soon as it is convenient or possible to do so. The signal itself will not be answered	Used when the receiving-station is unable to answer owing—(*a*) to the enemy being in the vicinity, and the position being thereby disclosed or signals read; (*b*) to a likelihood of the sun being clouded, or gas, oil, &c., running short; (*c*) to the station being short-handed, or if for any other reason it is found advantageous not to send answers. The sending-station will send each word, group, &c., twice, so as to increase the chance of its being read.
22. Send DD, DD messages	NA	By the general answer, then complying.	
23. No more messages coming at present	NN	By the general answer.	
24. Come in ..	CI	By RD, and complying	Sent on the conclusion of work for the day, or on vacating a station. Before moving off, a station will inform all others in communication with it that it is about to do so.

* Sent in one group, with a slight pause between the second and third D.

QUESTIONS AND ANSWERS.

ON MILITARY ENGINEERING.

1. What is the object of fortifications ?

   To strengthen ground, and swell the force available for offensive movements.

2. What three branches are fortifications divided into ?

   Permanent fortifications,
   Provisional fortifications,
   Field fortifications.

3. How does the nature of weapons employed affect field fortifications ?

   First, the penetration, searching-power, and destructive effect govern the amount and disposition of cover necessary for security.

   Second, the range and rate of fire influence the siting of works and regulate positions of obstacles.

4. Classify the different natures of fire.

   Frontal fire,
   Oblique fire,
   Enfilade fire,
   Reverse fire,
   High-angle fire.

5. What is the slope of a bullet at the following ranges: 1,000 yards, 1,500 yards, 2,000 yards, 2,500 yards, 2,800 yards ?

   1,000 yards, 1 in 30.
   1,500 ,, 1 in 12.
   2,000 ,, 1 in 6·5.
   2,500 ,, 1 in 3.
   2,800 ,, 1 in 1·25.

6. What thickness of the following materials is bullet-proof at 30 yards range: Clay, earth free from stones, sand between boards, brickwork, soft wood, hard wood, wrought iron, coal?

   Clay, 5 ft.
   Earth, 3 ft.
   Sand between boards, 18 in.
   Brickwork, 9 in.
   Soft wood, 48 in.
   Hard wood, 27 in.
   Wrought iron, $\frac{1}{2}$ in.
   Coal, 2 ft. 6 in.

7. What is the angle of cone of dispersion of shrapnel?

   20°.

8. What is the forward effect of shrapnel?

   300 yards.

9. What is the slope of descent of a shell from the field-gun at 1,500 yards and 4,000 yards.

   1 in 20 and 1 in 4.

10. How are slopes usually described in field-works?

    By fractions in which the numerator expresses the height and the denominator the base of the slope.

11. How are slopes converted into degrees? DEGREES SLOPES

    By dividing the number of degrees into 60.

    NOTE.—This rule holds good up to 30°.

12. What is the length of the R.E. pick?

    3 ft.

13. What is a task?

    The amount of work a man has to do in one relief.

14. What is a relief?

    A period of time usually four hours.

15. How much can a man excavate in one hour and four hours?

    One hour, 30 cub. ft.
    Four hours, 80 cub. ft.

16. How are tools usually laid out for working-parties ?
    In separate heaps about ten paces apart.
17. How close can men work when digging trenches ?
    Not closer than 4 ft.
18. In drawings, how is an area in square and cubic feet shown ?
    Square feet, □ ; cubic feet, ○.
19. What are profiles, and when are they used ?
    Profiles are wooden battens put up about 30 ft. apart in the construction of large works, and are to guide the working-party.
20. What tools are required by a tracing-party ?
    1 mallet,
    1 field level,
    1 5 ft. rod,
    1 measuring-tape,
    Picks and tracing-tapes as necessary.
21. Draw a working-party table ?

Number of Men.		Where at Work.	Nature of Work.	Task.	Tools.	Remarks.
Infantry.	R.E.					

22. Describe a fascine ?
    A fascine is a long faggot of brushwood 16 ft. long, bound every 18 in. with wire or a substitute.
23. What is a gabion ?
    A bundle of brushwood 2 ft. 9 in. high and 2 ft. in diameter, used for revetting.
24. What is revetting ?
    Making earth stand at a steeper slope than it would naturally do.

25. What length of time is required to construct a hurdle 2 ft. 9 in. by 6 ft. ?

3 MEN Two hours and a half.

26. What size should sods be cut ?

18 in. by 9 in. by 4½ in.

27. What is a clift peg ?

A peg driven into sods to keep them in position.

28. How many sods will two builders lay in one hour ?

100 sods without pegs.
70 sods with pegs.

29. How are earthworks classified ?

As trenches and redoubts.

30. How are trenches classified ?

As fire trenches and cover trenches.

31. Where are redoubts usually used.

On isolated positions.

32. What is a parallel ?

A system of trenches used in fortress warfare.

33. What is sapping ?

Sapping is constantly advancing a trench in the direction of the enemy. The earth is thrown on the exposed flank.

34. What advantages are derived from earthworks ?

They enable fire to be delivered under conditions favourable to the defence, and, by means of obstacles, limit the freedom of the attack.

35. In order to realise these advantages what points must one bear in mind ?

(*a.*) Choice of ground ;
(*b.*) Clearance of foreground ;
(*c.*) Concealment ;
(*d.*) Cover ;
(*e.*) Creation of obstacles ;
(*f.*) Communications.

36. What is meant by " active defence " ?

An active defence implies rigorous counter-attacks and even pursuit.

37. What is meant by "passive defence"?
    No object beyond the repulse of the attack.
38. What is the ideal site for a field trench?
    One where the best fire-effect can be obtained in combination with complete concealment of the trenches and of the movements of supports and reserves.
39. What are the advantages of trenches on high ground?
    The defenders feel more confident, and communications are more easily concealed, and also a better view of the enemy is obtained.
40. What are the disadvantages of the above?
    Plunging fire; trenches more easily located by attackers when at a distance.
41. How may concealment be obtained?
    (*a.*) By judicious siting;
    (*b.*) By assimilation to the surrounding ground;
    (*c.*) By keeping the parapet as low as possible.
42. What are dummy trenches?
    Trenches constructed to mislead the enemy.
43. When time permits, what should be done in siting the trenches?
    Careful study from the front and enemy's artillery positions.
44. What points are essential for designing trenches?
    To remember,—
    (*a.*) Bullet-proof parapet;
    (*b.*) Trench and parapet as invisible as possible;
    (*c.*) Interior slope as steep as possible;
    (*d.*) Trench wide enough for men to sit in;
    (*e.*) Protection from oblique and enfilade fire;
    (*f.*) Drainage.
45. What height can a man fire over—(*a*) standing, (*b*) sitting, (*c*) lying down?
    (*a.*) 4 ft. 6 in.,
    (*b.*) 3 ft.,
    (*c.*) 9 in. to 1 ft., respectively.

46. What way would you arrange corrugated iron in a trench to gain cover from shrapnel ?

Two sheets placed on top of each other sloping to the rear 1 in 4.

47. How can cover be gained from heavy artillery up to 6 in. ?

By a row of heavy rails covered by 3 ft. of earth.

48. What will the trace of a redoubt depend on ?

The proposed garrison, allowing 1 to $1\frac{1}{2}$ men per yard of parapet ; tactical considerations.

49. What distance should be left between loopholes.

At least 3 ft.

50. How long will it take a man to make a loophole in (*a*) brickwork, (*b*) with sandbags ?

Fifteen minutes and half an hour respectively.

51. What is an abatis ?

An obstacle constructed out of fallen trees and wire.

52. There are five conditions which obstacles should fulfil : what are they ?

(1.) Under close rifle-fire of defenders.
(2.) Should not afford cover to enemy.
(3.) Not liable to injury by artillery-fire.
(4.) Difficult to remove or surmount.
(5.) Concealed.

53. How many men are required to make an abatis of two rows 30 yards long ?

Twenty men in six hours.

54. What is the best form of obstacle ?

High wire entanglement, because quickly constructed and very efficient.

55. How much wire is required per square foot for low and high wire obstacles ?

Low wire, 1 ft. per square foot.
High wire, 3 ft. per square foot.

56. When is a low wire entanglement employed ?

Against mounted troops.

57. How many square yards of low wire entanglement will a man construct in an hour ?

10 sq. yd. with plain wire.
5 sq. yd. with barbed wire.

58. How many yards of square high wire entanglement will three men construct in one hour ?

10 sq. yd. with plain wire.
5 sq. yd. with barbed wire.

59. What is a fougasse ?

A land-mine filled with bricks and stones so arranged that when the charge is fired the stones are projected in a given direction.

60. What time is required to make a fougasse ?

Two men, seven hours.

61. If buildings stand alone, and exposed to artillery-fire, should they be defended ?

No, because time and labour in preparing them could be more usefully employed elsewhere.

62. What steps would you take to prepare a building for defence ?

(1.) Clear a field of fire.
(2.) Barricade doors and ground-floor windows, leaving one door only for use, which should be specially dealt with.
(3.) Loophole walls.
(4.) Prepare obstacles.
(5.) Barricade upper windows to a height of 6 ft.
(6.) Improve communications.
(7.) Set apart room for hospital, and prepare latrines.
(8.) In some cases make provision for inner defence.

63. What steps should be taken for defence of a village ?

(1.) Organize the sections of defence, and allot troops to them.
(2.) Provide loopholes.
(3.) Clear field of fire.
(4.) Provide communications.

(5.) Improve cover for outer line.
(6.) Make obstacles.
(7.) Prepare entrenchments.

64. What may houses be used for from a military point of view ?
(1.) Tactical point on battlefield.
(2.) As a keep to a village or locality.
(3.) As an isolated post on a line of communications.

65. What are the successive steps to be taken for a hasty defence of a house ?
(1.) Clear field of fire.
(2.) Barricade entrances.
(3.) Provide loopholes.

66. What are the four kinds of frame bridges used in the service ?
(1.) Single-lock, for spans up to 30 ft.
(2.) Double-lock, for spans up to 45 ft.
(3.) Single-sling, for spans up to 60 ft.
(4.) Treble-sling, for spans up to 80 ft.

67. How many types of trestles are there ?
(1.) 2-legged.
(2.) 3-legged.
(3.) 4-legged.

68. What depths of water are fordable ?
(1.) 3 ft. by infantry.
(2.) 4 ft. by cavalry.
(3.) 2½ ft. by artillery.

69. How do you find the velocity of a stream ?
Throw a stick into a stream, and see how long it takes to float, say, 100 yards ; or note the distance it floats in a given number of seconds, then seven-tenths of the number of feet per second will give velocity in miles per hour.

70. How do you find the buoyancy of a cask ?
Multiply contents in gallons by 9. For headless casks multiply gallons by 6½.

71. What is the weight of a cubic foot of water ?
    $62\frac{1}{2}$ lb.
72. How are hasty demolitions effected ?
    By means of explosives, axes, crowbars, fire, &c.
73. What is meant by " tamping a charge " ?
    Covering the charge over with earth, &c., so as to confine the gases at the commencement of the explosion and more fully develop their force.
74. What are primers used for ?
    For detonating wet gun-cotton.
75. What is a primer, and what sizes are used ?
    A piece of dry gun-cotton. The sizes used in the service are 1 oz. and 2 oz.
76. What weights are the gun-cotton slabs ?
    $1\frac{1}{2}$ lb. and $1\frac{3}{4}$ lb.
77. Why are the slabs kept wet ?
    For safety.
78. What is a rectifier ?
    A piece of wood supplied with each tin of detonators, for making the hole larger in the primer if the detonator will not fit well.
79. What is gun-cotton ?
    Cotton-waste steeped in acids and, when allowed to absorb a certain amount of them, pulped into dust, and then moulded into slabs.
80. What are the precautions in firing charges electrically ?
    (1.) See that the exploder is kept locked.
    (2.) Station sentries to keep back the public.
    (3.) Take the four ends of the lead with you.
    (4.) Test the exploder.
    (5.) If a miss-fire occurs, wait twenty minutes.
    (6.) Make certain that your leads are long enough to allow you to get far enough away from the charge.
    (7.) Be very careful in tamping the charge.
81. What are the essential points to look to in making up a gun-cotton charge, and placing it on the object to be demolished ?

(1.) See that the primer is dry.
(2.) Secure the detonator in the dry primer.
(3.) See that the charge is in contact with the object to be demolished.
(4.) No matches, or smoking, or any lights are to be allowed near.
(5.) See that all the slabs are touching each other.
(6.) See that the dry primer is secured to the wet charge.

82. What does a red shank on a detonator denote ?
That it contains fulminate of mercury.

83. What is Bickford's fuse ?
Slow-burning fuse that burns 3 ft. a second. It consists of gunpowder enclosed in two coatings of jute thread twisted in opposite directions to one another, waterproofed, and strengthened by layers of tape and gutta-percha.

84. What is instantaneous fuse ?
Quick-match enclosed in several layers of tape and burning at the rate of 30 yards a second. It will burn under water.

85. What sizes are the gun-cotton slabs ?
6 in. by 6 in. by $1\frac{3}{4}$ in., roughly.

86. How would you destroy rails by fire ?
By twisting them when red-hot.

ON SIGNALLING.

1. What governs the distance at which the flags may be read ?
(1.) Background.
(2.) Atmosphere.
(3.) Power of the telescope.

2. How is signalling effected with the heliograph ?
By reflecting the light of the sun by means of mirrors to a distant station, and exposing long and short flashes of light.

3. Which mirror should always point to the sun ?
   The signalling mirror, and not the duplex.
4. When the sun and the distant station make an angle greater than 120° with the instrument, which should be used, the duplex or the sighting vane ?
   The duplex always when the angle is greater than 120°.
5. In what shape do the rays leave the mirror ?
   Cone-shaped.
6. What distance apart should the legs of the stand be placed ?
   They should be placed so that the distance between the legs is about equal to the height.
7. In windy weather how can the helio. be kept steady ?
   By burying the legs in tins filled with earth, or suspending a weight to the anchoring-hook so that the weight just touches the ground.
8. How should the duplex mirror be packed ?
   Glass inwards.
9. How can the beat be altered ?
   By the beat-regulating screw.
10. If the helio. gets wet, what should be done ?
    The instrument should be rubbed over with an oily rag at the first opportunity.
11. Should a Volunteer strip a helio. ?
    No, not unless he has been given special permission to do so.
12. How much gas does a gas-bag hold ?
    $3\frac{1}{4}$ cubic ft.
13. How long will it last ?
    Forty minutes with care.
14. What is the pressure-bag used for, and how much does it require to keep the gas flowing steadily to the lamp ?
    14 lb. to 28 lb. pressure should be allowed for. This pressure makes the gas flow easily through the tubing and forces the methylated spirit flame on to the lime pencil.

15. What kinds of lenses are used in the lime-lamp ?

Two plano-convex lenses, with the convex surfaces towards each other, and the lenses $\frac{1}{2}$ in. apart.

16. What is the object of the wash-bottle ?

To cleanse the gas of impurities, and cool it.

17. How much water should be put in it ?

It should be about $\frac{1}{2}$ full.

18. How should the retort be cleaned ?

Wait till it cools ; then dissolve she residue in it by pouring hot water into the retort ; then scrape with a piece of wood.

19. What is the oxygen gas made of ?

Three parts of chlorate of potash and one of granulated binoxide of manganese.

20. How can you tell when the lime pencil is in the right position ?

By holding a piece of paper about 8 in. in front of the lens. If the upper part of the image is dark, the pencil is too far back ; if the reverse, the pencil is too far forward.

21. What kind of a fire is used for making the gas ?

A slow wood fire.

22. Before starting to make gas, what precautions should you take ?

(1.) See that the wash-bottle, tubing, and retort are clean.

(2.) See that safety-valve works freely.

(3.) See that the tubing and wash-bottle are clear for the passage of the gas.

23. On what side of the fire should the gas-bags be placed ?

On the weather side.

24. How can you tell when the gas is coming off ?

By holding a piece of stick which is glowing to the mouth of the retort, and if the gas is being given off it will cause a bright flame.

25. Why should the tubing be removed from the retort after the gas is made ?
    To prevent water getting into the retort.
26. What kind of a lens is fitted to the Regbie lamp ?
    A 6 in. bull's-eye lens.
27. What kind of oil is used with the lamp ?
    Mineral oil, having a flash-point of 150°.
28. How much oil does the reservoir hold ?
    Three-quarters of a pint.
29. How long will this last ?
    Ten hours.
30. How should the burner be cleaned ?
    Boiled once a fortnight.
31. How should the wick be trimmed ?
    It should not be cut, but trimmed with the fingers.
32. What kinds of signalling-stations are used with a field force ?
    Moving stations.
33. Is it necessary to enter in the code when you are on a moving station ?
    No.
34. Who has the authority to send clear-line messages ?
    Officers in charge of signalling arrangements.
35. Can any officer send a priority message ?
    Yes, if the message is of extreme importance.
36. Who are allowed to send in cipher ?
    Only officers.
37. Where should every message be signed ?
    In space Z.
38. May a signaller ever send a word otherwise than how it is written ?
    Only if a word is obviously spelt wrong, in which case he should ring the word, and carry it out to the margin of the message-form spelt properly.
39. Who is responsible for the receiving of a message ?
    The writer-down.

40. When is the stop signal used ?
    (1.) To send any instructions.
    (2.) To stop a message.
    (3.) At the end of every fifty words in a long message.
41. How do you call up the navy if you wish communication ?
    By day, with the naval and military pennant ; by night, with a succession of x's.
42. What numerals do you use when sending to the navy in Morse ?
    Long numerals.
43. How are the numerals sent in semaphore ?
    They should be spelt out.
44. When you are in doubt, what colour should you use ?
    White.
45. What are the first two things to be done on occupying a station ?
    Align the helio. and focus the telescope.
46. Are you allowed to disclose the contents of a military message ?
    No ; it is a serious military offence to do so.
47. If your station was surprised, what would you do to prevent the enemy from discovering the contents of your messages ?
    Destroy them if possible.
48. What orders should all signalling-stations have with them ?
    Orders giving the names of officers entitled to send priority messages, and amendments to the same ; orders prohibiting unauthorised persons from loitering in the vicinity of stations ; order requiring every message to be signed by the addressor or his deputy.
49. What is the magnifying-power of the service telescope ?
    Fifteen times with the low power, and thirty times with the high power.

50. How do you clean a very dirty lens ?

Drop two or three drops of spirits on it, and wipe carefully with a piece of silk. Never rub with the bare finger.

ON ELECTRICITY.

1. What are the effects of an electric current when flowing through a conductor ?

Magnetic effect, thermal effect, and, if the current passes through an electrolyte, a chemical effect will be apparent.

2. In order that a current of electricity may flow, what two conditions are necessary ?

(*a.*) There must be a complete conducting-path.

(*b.*) There must be in that path an electro-motive force.

3. Name three sources from which an E.M.F. may be obtained ?

(1.) Primary batteries.

(2.) Accumulators.

(3.) Generators.

4. What type of batteries are used in the service for field telegraph and telephone work ?

Primary batteries.

5. What are conductors ?

All materials that will allow a current to pass through them with little or no resistance.

6. What are insulators ?

Those materials that offer high resistance to the flow of an electric current.

7. Name the chief units used in the measuring of electrical currents.

Unit of force—the volt.
" resistance—the ohm.
" current—the ampere.
" quantity—coulomb.
" capacity—farad.
" power—watt.

8. Express Ohm's law as an equation.

$$\text{Current in amperes} = \frac{\text{E.M.F. in volts.}}{\text{Total resistance in ohms.}}$$

Or $E : C \times R.$

Or $R = \frac{E.}{C.}$

9. What is meant by an earth return ?

Using the earth as a conductor instead of using wires for a return.

10. What are the first laws of magnetism ?

Like poles repel and unlike attract.

11. What is the most simple form of a primary cell ?

Two dissimilar metals placed in a jar containing dilute sulphuric acid.

12. What is local action, and how can it be remedied ?

Local action is the forming of a small cell within the main cell itself, causing a current to flow when the cell itself should be at rest. It is generally due to impurities in the zinc plate. The remedy is to amalgamate the zinc plate by coating it with a film of mercury.

13. What is polarisation, and how can it be remedied ?

Hydrogen gas liberated by chemical action in a cell deposits itself on one of the plates, and causes high resistance in the cell. It can be remedied by placing material rich in oxygen alongside the positive plate. Hydrogen has a great affinity for oxygen, and will mix with it, forming water.

14. How can the positive and negative poles of a cell be shown conventionally ?

The positive by a long thin line, and the negative by a short thick line.

15. What are the factors that govern the resistance of conductors ?

Nature of the material, its length, its breadth and thickness ; temperature.

16. What is a divided circuit ?

A circuit having more than one path open to the flow of an electric current.

17. Explain the principles of the telephone.

Sound-waves may be converted into electrical energy, and *vice versa*. The telephone enables us to transmit over considerable distances in the form of variable electric currents, which are again converted back into sound-waves at the receiving end.

18. What telephone is used for field-telephone work ?

The D, Mk. II.

19. What type of cells is used with it ?

Obach dry cells of the S type.

20. Give a description of the S type Obach dry cell.

It is $4\frac{1}{2}$ in. high, $1\frac{1}{2}$ in. square ; internal resistance, $\frac{1}{2}$ ohm ; E.M.F., $1\frac{1}{2}$ volts.

The cell consists of an exciting paste-carbon rod ; zinc pot contained in an insulated receptacle.

A depolariser is placed against the carbon rod to prevent local action. Sawdust is placed on top of the paste. A vent-hole is on the top of the cell to allow the free gases to escape.

21. What does a condenser consist of ?

Sheets of tin-foil separated by a good layer of insulating material.

22. How can primary cells be tested ?

The internal state of the battery can be accurately guessed by noting the deflections produced on the two coils of the Q. and I. detector, and comparing them with those produced by a battery known to be in good condition.

NOTE.—Be careful and do not short the battery longer than can be avoided, or the cell will quickly become polarised.

23. Explain the action of the vibrator ?

A current flowing round the coils of the electro-magnet when a key is depressed causes an armature to be drawn away from a stop ; this at once breaks the circuit through the magnet-coils, and the armature springs back into its old position, completing the circuit again, but it is immediately withdrawn from the stop again, and the armature is continually kept vibrating (with the resultant buzzing noise).

24. Explain the field service electrical detonator ?

It consists of the head, shoulder, and shank. Two wires pass into the interior of the head, at the end of which is a small piece of platinum wire about $\frac{1}{4}$ in. long. The wires are insulated from each other except where the platinum wire joins them. The platinum-wire bridge is surrounded by a priming of fine-grained powder and gun-cotton dust. The shank of the detonator is the small narrow portion, and contains fulminate of mercury. About 25 gr. are in this shank.

25. What does a red shank on a detonator denote ?

That it contains fulminate of mercury.

26. How does the detonator act when a current of electricity is sent along the wires ?

When sufficient current passes along the wires, the platinum wire gets red-hot, and the priming around it catches fire and sends a flash down into the shank to the fulminate of mercury. The fulminate at once detonates, and, if it be in contact with gun-cotton, detonates it also.

27. Can you fire detonators in parallel with the exploder ?

No ; they are so sensitive that one will always fire, and not enough current will have been generated to cause both to do so. It should be remembered that when the handle of the exploder is at the bottom of its run there is no more current being sent to line.

28. How can the exploder be tested ?

By placing a piece of platinum wire in the clips, and connecting up the field service bridge to the exploder itself. Bridge over the key of the box with a piece of wire, and then take out resistance in the box, say, 10 ohm ; press down the handle of the exploder quickly, and, if the wire fuses, place another piece of wire in the clips ; take out more resistance, and keep repeating until you can just fuse the wire. When you cannot fuse through any more, add up the resistance you have out of the box, and that is the resistance you can fire through.

NOTE.—One wire should go from the exploder to the wandering-plug, so that you can get to fractions of the ohm.

29. What effects will bad joints have on an electrical circuit ?

They will cause high resistance.

30. How may the resistance of the leads be tested ?

By balancing them with Wheatstone's bridge.

31. What is the resistance of the field service detonator ?

About $\frac{1}{2}$ ohm.

32. In what different ways may cells be connected up ?

In series, in parallel, in compound.

33. How do you connect up in series ?

By joining the carbons of one cell to the zinc of its neighbour.

34. How do you connect up in parallel ?

By connecting all the zincs together and all the carbons together.

35. How do you connect up in compound ?

By having some in series and some in parallel, all connected together.

36. What do you understand by " creeping " ?

The salts contained in a cell will exhibit a peculiar capillary action, and the liquid will in time creep over the top of the cell and empty it if left too long. This

creeping can be got over by wiping the cell with a rag damped in paraffin-oil every few days.

37. How many telephones may be allowed on the one circuit for field-telephone work ?

Not more than three should ever be put on the one line.

38. What are tests for the D Mk. II telephone ?

For the vibrator, press button. Vibrator should buzz ; if not, fault may be,—

(1.) Battery.
(2.) Armature out of adjustment.
(3.) Disconnection in primary, secondary, or leads.
(4.) Short circuit in vibrator condenser.
(5.) Dirty switch.

Speaking-circuit : Connect the two line terminals. and move microphone switch. Clicks should be heard in the receiver ; if not, fault may be,—

(1.) Weak battery.
(2.) Dirty microphone switch.
(3.) Disconnection in primary, secondary, or leads.
(4.) Faulty microphone.

39. What is the resistance of a mile of field cable that we use ?

63 ohms per mile ; and weight, 84 lb. per mile.

40. What is this cable known as in the service ?

D5, Mk. 4.

41. Explain the action of the Field sounder ?

When a current flows through the coils of the instrument the cores become magnetised, attract the armature, and pull down the lever against the pull of the spring. A stop on the instrument prevents the armature from touching the cores. If allowed to do so it would stick there when the current ceased, instead of being drawn up against the upper stop by the spring. The instrument should be very carefully adjusted before working, and this is done by adjusting-screws. Every time the armature is caused to move,

a metallic sound is made, and the dot and dash of the Morse alphabet can be readily sent.

42. What type of cells is used for this instrument ?

Obach dry cell of the O type.

43. Give a general description of the cell ?

E.M.F., 1·53 ; internal resistance, 0·15 ohms. The cell is square in shape, and the inner parts are the same as the S type as used for the D Mk. II telephone.

44. What can be done with dry cells that are run down ?

Dry cells are of little use if their E.M.F. falls below 1 volt. Under these conditions they may be converted into wet cells as follows :—

(*a.*) Remove the bituminous cover, and add sal-ammoniac solution of salt and water.

(*b.*) Remove the cardboard case, perforate the zinc in several places, and place the cell in a receptacle containing salammoniac solution.

45. A solution of the following problem is required : A certain electrical instrument requires $\frac{1}{20}$ ampere to work it, and has a resistance of 100 ohms : can it be worked through a pair of copper wires (resistance, 6 ohms per mile) from a point twenty miles distant by a battery of ten dry cells, E.M.F. 1·4 volts each, internal resistance 2 ohm each ?

Here $\frac{1}{20} = \frac{10 \times 1{\cdot}4}{10 \times 2 + 12 \times x + 100} = x$: $13\frac{1}{3}$ miles.

No ; other wires would have to be used.

46. A mine requires a current of 1 ampere to fire it. How many cells of the Obach O type will be required ? The resistance of the leads is 4 ohms.

Let x : the number of cells required ; then

$$\mathrm{I} : = \frac{1{\cdot}5x}{0{\cdot}5x + 4} = 1x = 4 \therefore x = 4 \text{ cells.}$$

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OVER HEAD COVER

Not to Scale