# THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL

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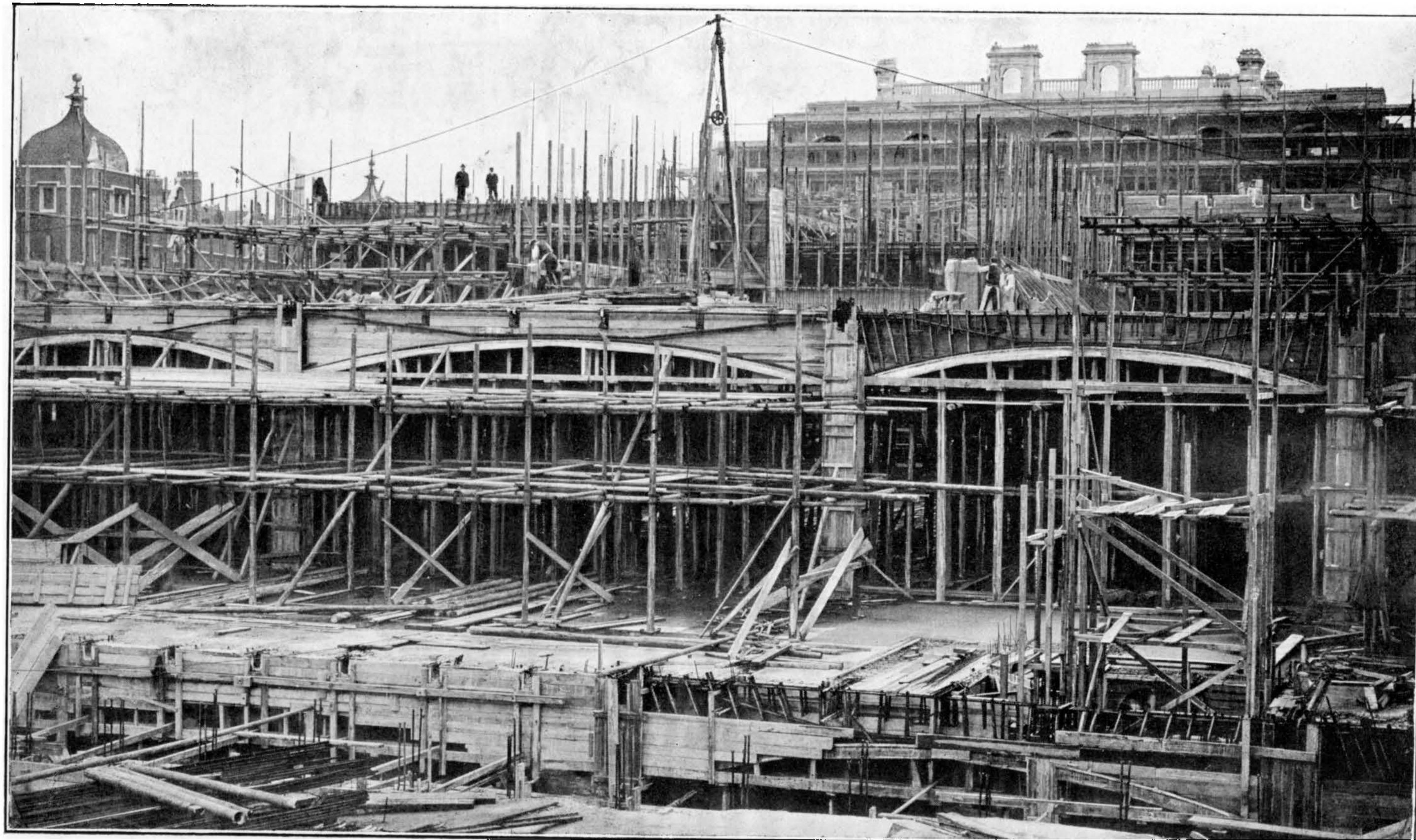


I.—View looking E., showing Beams in Ground and First Floors, with Roof of the G.P.O. (N) in the background.

THE

# Post Office Electrical Engineers' Journal.

## THE NEW GENERAL POST OFFICE. (KING EDWARD'S BUILDING.)

By E. W. PETTIT.

THE following notes on the "King Edward's Building" now in course of erection may prove of interest to our readers, as the building itself undoubtedly is, to members of the public, many of whom stop to gaze on the unclothed skeleton rearing its head skywards with awe, mixed in some cases with not a little concern as to its safety.

The site is that previously occupied by Christ's Hospital, better known as the Bluecoat School, and is 156,800 square feet or just over 3½ acres in extent. The present building occupies roughly two thirds of this site, provision for extension being made at the west end. The foundation slabs are carried down to a depth of 31 feet, necessitating the excavation and removal of 128,000 cubic yards of earth, weighing upwards of 190,000 tons.

The strata of the ground was generally as follows: made ground, consisting mainly of foundations for the old Christ's Hospital building to a depth of 21 ft., 2 ft. 6 in. of loamy clay, 15 ft. 6 in. of ballast and river sand, and finally London clay. The foundation slabs go about 4 ft. into the ballast.

The river sand found in the ballast has, after screening, been used, resulting in a large saving in the cost of concrete.

A number of curios were found, Roman coins, pewter and old ware pots, etc.

Of interest also was the old Roman Wall, running right across the site, and now completely demolished. Its height was about 13 ft., width 8 ft. The foundations were of clay, covered with several layers of rough Kentish ragstones, then a course of sandstone blocks, a second series of roughly squared ragstones, a bonded layer three deep, of red tiles, a third course of ragstones, a second bonded layer of red tiles, and finally one or two layers of ragstones, the wall above this having evidently been removed when Christ's Hospital was built. The wall appeared to me to be in perfect condition, a tribute to the quality of the Romans' work.

In one spot several iron bars, used to bond the brickwork, were discovered. The iron had retained its original bloom and was quite free from rust. It is believed this work was carried out over 100 years ago, as part of the Christ's Hospital foundations. The condition of the iron bears out the argument of ferro-concrete advocates that these structures have an indefinite life.

The Contractors obtain current from the City of London Electric Light Co. at 400 volts D. C. for power and 200 volts D. C. for lighting. The woodworking machines, ballast screens, crushers, concrete mixers and hoists are all motor driven, and some 120 h.p. is used for this purpose. A number of arc and incandescent lamps are used for temporary lighting.

As is well known the form of the building is built up by means of timber centering and shuttering, the steel being placed in the moulds thus formed; the concrete is then poured in and rammed to prevent the formation of voids. It will be seen that the timber work must be sufficiently strong to take the whole weight of the steel and concrete until the latter has thoroughly set. Timbering may be removed after fourteen to thirty days, depending on weather conditions and the load on the structure; struts supporting the beams should be left for five to six weeks. In the case of walls, etc., carrying little or no load, shuttering may be removed after two days.

Although the timber is used several times, it is estimated that over 2,500 tons will be necessary.

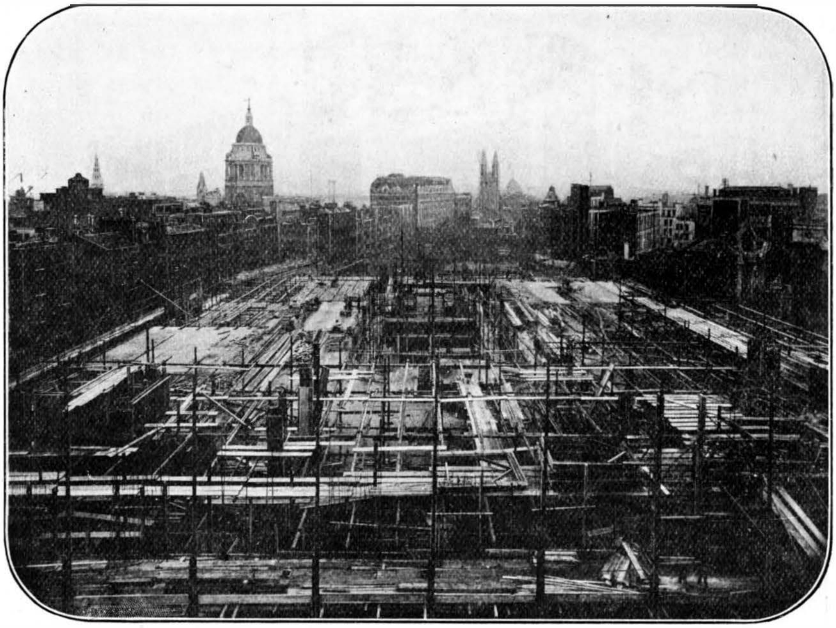
The method of construction will be seen from the frontispiece, in which the construction of an arched beam is shown in four different stages. On the upper floor the steel skeletons are visible, and it will be noticed that the tension bars on the lower side of the beam are of two kinds: one pair follows the curve of the beam, the second pair being cranked, and rising to the upper side of the beam at the haunches. The compression bars along the upper face are straight; all the bars are carried for several feet into the next beam, and have fish-tail ends, to prevent their being drawn out of the concrete by excessive strains. The concrete web is reinforced by stirrups of flat steel passed over the bars, and in intimate contact with them. By these means the stresses on the lower bars are transmitted to the upper bars and the concrete.

It should be noticed how the bars and stirrups are distributed so as to resist the maximum bending stress in the centre, and the maximum shearing stress at each haunch of the beam, where the stirrups are much closer together; also that additional bars passing through each column are provided, to further increase resistance of the beams to shearing stresses.

The steel is bent while cold by means of Jim Crows, but the fish-tail ends are opened when the metal is red hot. The two beams on the lower floor are in more advanced stages.

It is estimated that 3000 tons of steel of all sizes will be used, about one third of the weight necessary for a steel-framed building of the same size. Upwards of 21,000 cubic yards of concrete, weighing 31,500 tons, will be required, the whole being mixed by machinery.

The building will be absolutely fireproof; the fiercest fire would only destroy the internal fittings, leaving the structure practically



2.—View of Sorting Office Block from roof of Public Office Block, looking West.

unharmed. The concrete is impervious to moisture; there is thus no tendency for the steel to rust.

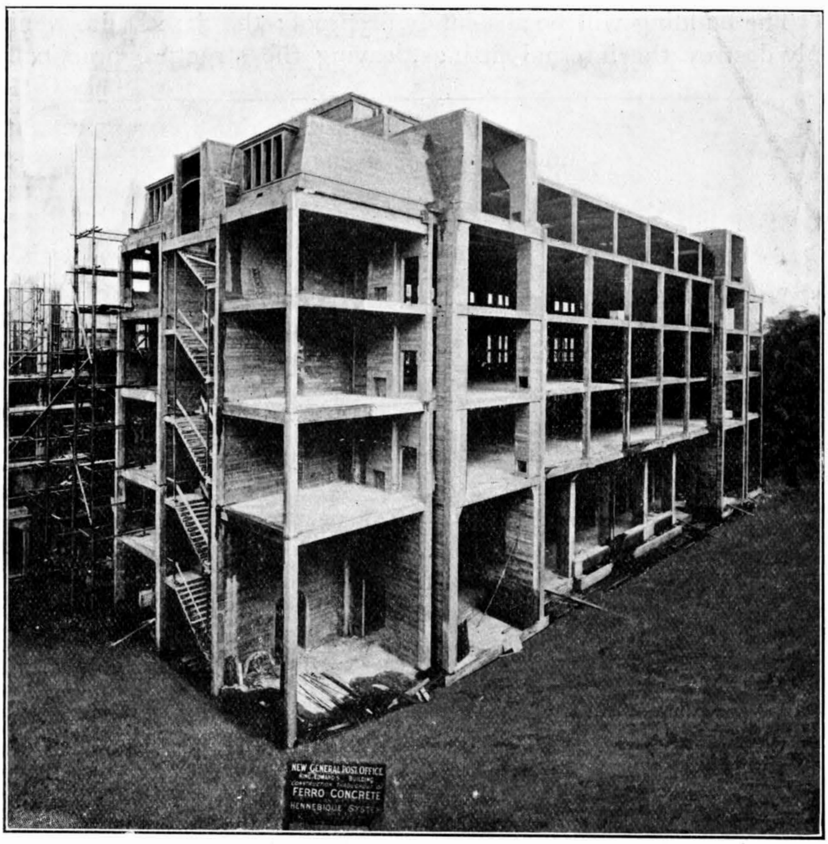
The effective area, and cubical contents of the building in ferro-concrete, are much greater than would have been the case in brick; for instance, the retaining wall is buttressed and 8 in. thick; in brick or plain concrete it would probably have been 4 ft. thick; the floors are 3½ in. thick against 8 in. of the ordinary floor.

The cost of ferro-concrete for large buildings is less than that of brick.

Some figures as to the size of the building will help readers to form an idea of the spacious premises which the London Postal Service Department will occupy on completion of the work.

There are two floors below the ground—subground and basement—the basement floor being 25 ft. 6 in. below the pavement level.

The total length of the Sorting Office on the ground floor is 320 ft., the width of the west half 210 ft., that of the east half 180 ft., *i.e.* upwards of 625,000 sq. ft. between walls—a room of truly noble proportions. On the two lower floors the area between walls is 820,000 sq. ft., the extreme length being 420 ft. The height from the




3.—Public Office Block, looking W., showing Elevation to King Edward Street, in Readiness for Stone Front.

street level of the front building, known as the Public Office Block, is 84 ft., that of the building in the rear, known as the Sorting Office Block, is 76 ft.

The entire ground floor of the Public Office Block will be devoted to the Public Office, access being obtained at each end through entrance halls seen in photograph No. 1. The office itself is 150 ft. long, 50 ft. wide, and will have a finished height of 19 ft. 6 in.; the decorations are, I understand, to be of a very fine character. Each of the main beams carrying the upper floors contain 30 tons of concrete and steel. The four floors above will be used as offices for the executive staff of the London Postal Service; two lifts will be provided to serve these floors. The front and sides will be of stone on a granite base, the back of ferro-concrete. A feature of interest observable near the ground line at the front of the building is the provision for post-boxes. Letters and parcels will be dropped through the three huge openings and will fall on to travelling bands.

The sorting office is entirely of ferro-concrete, with the exception of the Newgate Street front 100 ft. in width, which will be of stone similar in design to that of the Public Office. The sub-ground, ground, first and second floors will be devoted entirely to dealing with the mails, the necessary storage space being afforded in the basement, while the retiring and dining rooms for the staff are located on the third floor.

Ten large lifts will be provided to facilitate the transference of the staff and correspondence from floor to floor, and in addition a number of mechanical conveyers, for distributing the mails from the large posting boxes in front of the public office, will be installed.

The building will be warmed and ventilated by means of a hot-water heating system; fresh air will be drawn in from behind the radiators, and the vitiated air extracted by means of large exhaust ducts and fans. The ventilating system will be applied to the lavatories also.

A plant to supply all necessary steam, a complete telephone system, and a high-pressure fire service fitted with the most recent appliances will also be installed. The current for lighting and power will be obtained from the Post Office power station.

It will be seen from these few notes that everything that modern engineering skill can devise is being used to equip the "King Edward's Building" for the purpose it is intended to fulfil, and I think that, when the building is completed, the British Post Office may congratulate itself on possessing one of the largest and best equipped sorting offices in the world.

The photographs showing the construction have been taken by the kind permission of Mr. R. J. Allison, chief assistant to Sir Henry Tanner.

# THE CULT OF THE CLERK.

THOREAU, who at no period of his life was a civil servant, has said that the mass of men lead lives of quiet desperation—what is called resignation being confirmed desperation. It is good to have this independent testimony that quiet desperation is by no means peculiar to civil servants, though by the very nature of things it is one of their characteristics and even one of their privileges. Unless the average clerk in a Government Department can see that any change which may be contemplated is in his interests he will, as a last resource, relapse into that quiet desperation of which Thoreau speaks, and this subject is approached with the hope that in at least one instance the feeling will be dispelled.

To hint at changes under such a title as this article bears may be to spread undue alarm, but when the germs of higher technical and commercial training infect a Department it would be folly to suppose that they will confine their attentions to the engineering officers in that Department and leave the clerical officers unscathed, unless, of course, it is taken for granted that the former class need their attentions more. Modesty, if nothing else, absolutely forbids us to take this view, and signs and indications are not wanting to show that before long those who, for various reasons, have considered it unnecessary to improve their knowledge of commercial subjects, may, in their own interests, deem it wise to do so.

The attainment of fluency in certain foreign languages and proficiency in such subjects as accountancy, commercial law and political economy is the desire, if not the ambition, of many clerks; but most of us, immediately after passing a keen competitive examination, have felt with Lowell, though from a different cause,

> "o'er us stealing
> The old familar, warm, champagny, brandy-punchy feeling,"

and so far as our books and studies are concerned we have cried, "*Jam satis, superque*," and have determined for the time being to abandon the strenuous life for such pleasures as are obtainable on a salary of £80 per annum.

That this feeling is very natural except in the case of the ubiquitous Scotchman will scarcely be disputed, but, as Locke has it, "When the mind has been once habituated to this lazy recumbency and satisfaction on the obvious surface of things, it is in danger to rest satisfied there." It is at this period that a sad mistake is often made and the acquisition of a knowledge of commercial subjects considered unnecessary or deferred until the spirit is no longer willing and it is too late to commence.

The contrast with the behaviour of a clerk who enters an insurance office or commercial house is marked. His studies, instead of being on the point of completion, are only just commencing, because he knows that if he intends to make his way he must improve his acquaintance with foreign languages, pursue his studies in commercial law and kindred subjects, in short, learn anything and everything which by any conceivable chance may be of assistance to him. It may be argued that he will receive his reward and that his promotion will be rapid, whereas in a Government Department seniority must be taken into account. Granted that this is so to a certain extent, it surely cannot excuse a civil servant neglecting to obtain even a passing acquaintance with subjects which will undeniably assist him in his work, and render him not only a better servant to the State, but a more intelligent citizen.

In stating, therefore, that a clerk in a Government Department should follow the example of his brother officer in the commercial world, and proceeding to the logical conclusion that his proficiency in the subjects he studies may be tested by examination, we come to the vexed question whether the result of any examination can be regarded *inter alia* as a true test of efficiency? No better reply can be quoted than that given by Lord Macaulay when he replied to criticism concerning examinations in the Indian Civil Service: "Whatever be the languages," he says, "whatever be the sciences which it is in any age or country the fashion to teach, the persons who become the greatest proficients in those languages and those sciences will generally be the flower of the youth, the most acute, the most industrious, the most ambitious of honourable distinctions. If instead of learning Greek we learned the Cherokee the man who understood the Cherokee best, who made the most correct and melodious Cherokee verses, who comprehended most accurately the effect of the Cherokee particles, would generally be superior to a man who was destitute of these accomplishments."

Cherokee would be of little assistance to a clerk engaged on an intricate accounting duty unless perhaps it enabled him to give vent to his feelings in audible tones without fear of reprimand, but a knowledge of commercial systems of cost accounting might enable him to effect by representation a simplification of the system to which he is tied, and thus assist him to perform his duties to the greater satisfaction of his superior officers. One cannot thrive on one virtue, and it is certain that if the clerks of any Department determined to perfect their knowledge of up-to-date business methods they, as well as their Department, would materially benefit.

This duty, if it is acknowledged to be such, is not cheerfully and spontaneously undertaken by many unless there is associated with it a definite promise of reward. Unpalatable though the thought may be, it must be acknowledged that the hope of reward for the thing done is day by day becoming subordinate to the fear of displeasure and ostracism for the thing left undone. Let us explain.

Business methods are making rapid progress in Government Departments; red tape is becoming powerless before the onslaughts of card indexes, machine calculators, and girl clerks; commercial methods of accounting are slowly but very surely being admitted; in a few years' time there will come under Government control an extensive business concern with its complement of business men, and at the transfer any remnants of the old order which may remain will have to fight for their existence with the new. It can be imagined what, then, will be the position of an officer who has been content to cry "*Jam satis*," and who is acquainted only with obsolete or obsolescent methods. To equip oneself with information over and above that required for the bare performance of one's daily duty must for these reasons be regarded first and foremost as one of the first principles of self-preservation, and secondly as instituting a claim for better conditions of service.

Experience shows that as a rule better conditions follow, and not precede a betterment of the intellectual fibre of a class. Ruskin tells us that that country is richest which nourishes the greatest number of noble and happy human beings, and the same may be said of any Government Department or commercial undertaking. It is recognised that the more prosperous the condition of any State or body the more flourishing is the condition of the units which go to compose it. Further, it is morally certain that the Department or Office which contains the Achilles, the Alexanders, and the Cæsars will thrive and be pre-eminent and the well-being of its employees will be materially improved.

Under such circumstances an incentive to study will, it is thought, be welcomed rather than ignored, and in future a question similar to that put by Lord Rosebery at Glasgow when he said, "What is the hall-mark which this University stamps upon its men?" may be asked of our Department and replied to with confidence. We may not all be able to reach the lofty pinnacle of knowledge where sate the village schoolmaster of whom it is said:

"The village all declared how much he knew,
'Twas certain he could write and cipher too,
Lands he could measure, terms and tides presage,
And even the story ran that he could gauge."

But we can do our best.

T. B.

# LOCALISATION OF FAULTS ON UNDERGROUND CABLES.

By H. P. Brown.

It frequently happens during the construction of a main underground cable that modifications must be introduced in the ordinary form of Wheatstone-bridge testing before defects arising from various causes can be localised. On such cables it is essential that very accurate measurements should be possible, otherwise the cost incurred in removing a fault may be excessive. This paper is intended to suggest the nature of certain modifications which may be found useful.

It is perhaps safe to say that the two classes of fault which are most troublesome to deal with are high-resistance earths, especially if intermittent, and disconnections.

A high-resistance earth fault, sometimes showing several megohms with a normal voltage, is usually the result of one of three things, viz.:

(1) Small metallic particles find their way into the cable and get between the screening tape of screened conductors and the wire itself, or between the wire of unscreened conductors and the lead sheath, and ultimately pierce the insulation paper.

(2) The burr on the edge of a screening tape where the spiral tension is excessive, pierces the insulation paper.

(3) A projection on the wire itself, either at a manufacturer's joint or at an ordinary cable joint, pierces the insulation paper.

A defect of this nature in an actual cable length may not be revealed during the factory tests, but may develop while the cable is being drawn in and jointed.

For localising a high-resistance earth the ordinary loop method is used, but in place of a battery consisting of a few cells, a high voltage is applied. A convenient source is the generator of a 500 volt "Megger," which form of insulation testing instrument is now used almost universally. By this means, and by using an ordinary horizontal D'Arsonval galvanometer, having a sensitivity such that one millivolt gives a deflection of fifteen divisions, faults have been localised with considerable accuracy. The high voltage breaks down the fault and the resistance remains during the application of the voltage at a comparatively low value, while the output of the generator is insufficient to cause damage to the bridge.

The general principle of the test is perhaps almost too well known to need comment, but for the sake of convenience it is indicated in 1.

If $R$ = res. in ratio arm
$R_1$ = ,, ,, bridge, or adjustable rheostat arm
$L$ = ,, of half-loop in ohms or represents length of half-loop in yards if both wires have equal res.

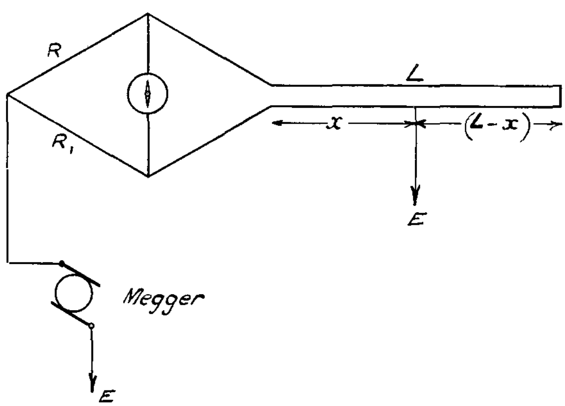
Then $\frac{R}{R_1} = \frac{L + L - x}{x}$

*i.e.* $x = \frac{2\,LR_1}{R + R_1}$.

It is, of course, advisable to make a number of measurements from both ends of the cable, and it simplifies matters, at any rate in the final test, to insert values for $L$ in yards and not ohms. Then the distance of the fault is given direct in yards.

*Disconnection.*—The localisation of a disconnection would be a comparatively simple matter if a reflecting galvanometer, a Rymer-

I.




Jones discharge key and standard condenser, were available, and if suitable accommodation for setting up such apparatus could be secured on the road, but the method is out of the range of every-day practice. The following arrangement has, however, met with much success in actual practice, and has given very accurate localisation tests. It is simple and does not require any special care in manipulation.

It is an adaptation of the Bridge method of measuring capacity, and has the great advantage in this class of work of being a null method. The ordinary horizontal galvanometer previously referred to can be used.

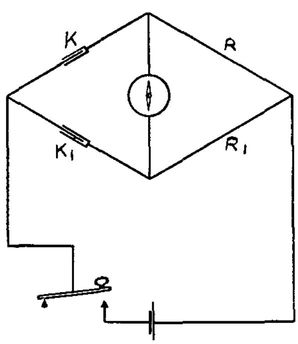
The theory of the test, which is particularly simple, is here illustrated (**2**).

No deflection would be obtained when $\frac{R}{R_1} = \frac{K}{K_1}$ and, therefore, when this condition obtains $K_1 = \frac{R_1 K}{R}$.

In a direct measure of the capacity of a condenser, $K$ would, of course, represent a standard condenser.

Assuming that the localisation test is to be made on a cable under construction the measurements should be made from the end of the completed section, and the following length of cable used as a standard of comparison. The essential feature of the test is to select wires in the length to be used as a standard, *i.e.* to take the place of "$K$" in **2**, similar in electrical characteristics to the faulty wire. Should the fault be on a screened wire a number of screened wires in the standard length are bunched until the capacity approaches the capacity of the defective wire between the testing point and the fault, and the final adjustments for no deflection may then be made by the Bridge resistances. If the faulty wire is not screened and is in twin formation, the corresponding class of wire in the standard

**2.**




length should be looped at each end so as to obtain the required length, and one of the wires must then be earthed. In each of these cases the capacity of the standard will then be proportional to the number of lengths used. If, now, the length of standard cable is accurately measured in yards the actual distance of the fault is readily calculated from—

$$K_1 = \frac{R_1 K}{R}$$

where $K$ and $K_1$ represent the lengths in yards corresponding to the capacities.

About 100 dry cells of small internal resistance should be available for this test. It is an advantage to vary the number of standard lengths and obtain a balance in each case by the Bridge resistance, finally taking the average of the results so obtained.

## PROFESSIONAL PAPERS.

The attention of readers is called to the announcement on p. 2 of Supplement.

# CENTRAL TELEGRAPH OFFICE.

For some time engineering changes in the wiring arrangements of considerable magnitude have been taking place in the Central Telegraph Office, and now the cabling and general wiring is as well arranged as it can be, having regard to the fact that the General Post Office West Building is not particularly suitable for housing the largest Telegraph Office in the world.

The objects aimed at were, in the first place, to secure immunity from fire risks, and secondly, to facilitate and reduce the cost of changes in the positions of circuits, which the exigencies of the traffic in the C. T. O. appeared so frequently to demand.

In October, 1907, the final installation of the Metropolitan Inter-communication Switch was completed, and as a consequence of the amount of table space set free, and for other reasons affecting staff administration, a re-organisation of the Central Office was decided upon. The work, according to a return which the Controller prepared, involved the removal from one portion of the building to another of nearly fourteen thousand pieces of apparatus, and was accomplished without the slightest hitch or delay to traffic.

The circuits are now located as follows:

*Ground floor.*—Switch Working Sets for Tube Office traffic and the Message Telegram Room.

*First floor.*—Telegraph School.

*Second floor.*—Cable Room—circuits working to South-South-East Offices, minor Midland and Northern Offices.

*Third floor.*—Main Provincial circuits, also Scotland, Ireland, and the Channel Isles. On this floor also are the News and Special Sections.

*Fourth floor.*—Metropolitan Inter-communication Switch, its working sets, direct circuits to certain Metropolitan Offices, and circuits working to the Home Counties.

Incidentally an increase in the number of Cord Telegraph Carriers, Concentrator Switches and a re-arrangement of the Pneumatic Tube System were contemplated, but these portions of the scheme are being proceeded with slowly.

Experiments are now being conducted with a view to determine the most suitable arrangement for working the pneumatic tubes automatically.

Two types of valve are being tried, one actuated by what may be termed a pneumatic relay, and the other being operated electrically.

Authority has been given for a trial of the Murray System to Berlin, the apparatus now in use at the C. T. O. on a Dublin circuit being utilised.

Efforts have for some time been made by inventors to increase the speed of preparing slips for Wheatstone Automatic transmission.

It was, of course, at once realised that the typewriter principle was the correct one, and this has been adopted by all the inventors. The first system tried was the Creed, which used air for perforating.

Recently M. Kotyra, of Paris, devised an arrangement by which the pneumatic perforators in use in the C. T. O. were operated by three solenoidal electro-magnets placed over the valve pistons. A typewriter keyboard is employed, the depression of the keys bringing into action a motor-driven rack and pinion device which provides by means of a brush passing over horizontal segments for the completion of the electro-magnet circuits.

M. Kotyra has recently modified his apparatus, dispensing with the pneumatic perforator and operating a four-slip perforator directly by solenoidal electro-magnets of more powerful construction. He has also introduced a much improved form of keyboard.

The Gell two-slip keyboard perforator, which was originally tried in conjunction with a key-speed Wheatstone transmitter for sounder working, and a four-slip perforator of similar but stronger construction are also being tried experimentally in the News Division. In the Gell instruments each letter or figure is perforated by one operation, and in this respect the Gell differs from the Kotyra.

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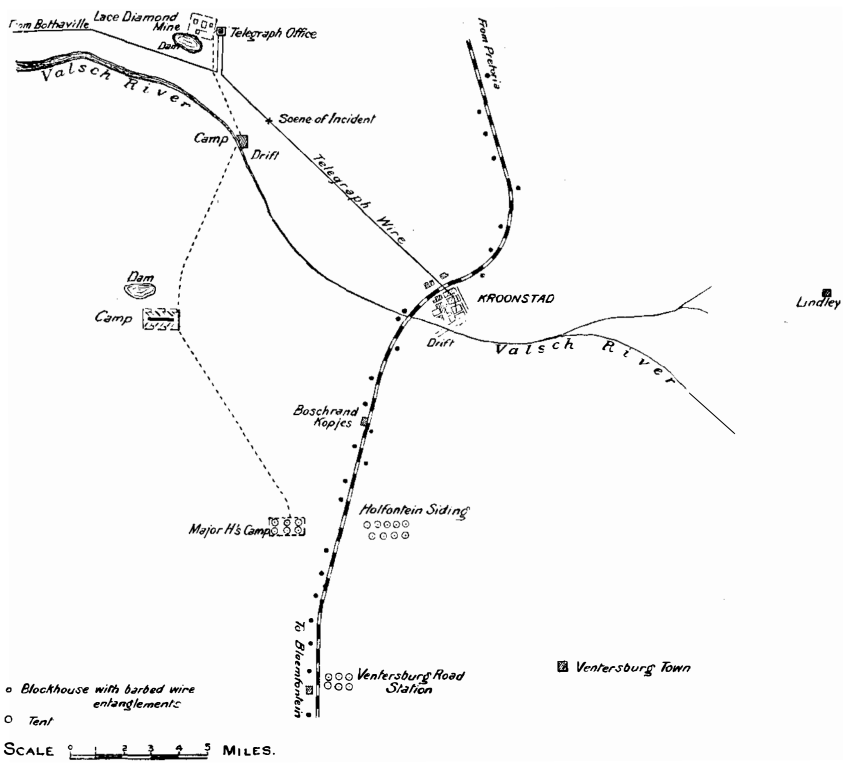
## TAPPING ON TO KROONSTAD: A REMINISCENCE OF THE BOER WAR.

A STIFLING mid-summer's day towards the end of 1901 and the military operator of Holfontein Siding dozed on his blanket bed under the shelter of the regulation bell tent. Presently the faint call of the "buzzer" broke the stillness; //// //// //, //// //// //, it called. The message that followed instructed the operator to pack up his apparatus at once and report himself to Major H—, who commanded a fighting column camped close by. Major H— had obtained permission to include a telegraph operator amongst his supernumeraries, so Sapper 3456 found himself installed in a spare Cape cart, which had been allotted to him as a travelling telegraph office. Next morning he woke to find the camp astir, though it was still dark. Huge fires of broken waggons, *pianos*, carts, etc., blazed all round, and the cooks were busy preparing an early cup of coffee before starting. No time was lost in packing up, and the whole column was soon moving slowly over the veldt, before the sun had risen.

On the second day the Column came within sight of a telegraph line, some two miles distant, and the order to pitch camp having been given, the operator drove off to tap the line and endeavour to get into communication with Kroonstad. The sapper was young and thirsted for glory, and on reaching the line he soon scaled an iron pole and teed a lead to the telegraph wire. After calling KDN for a time he got an answering signal, and an appointment was made to speak again at 7 p.m. The lead and instruments were left so that no delay might occur, and the operator drove back to the camp.

Major H—, when he heard of the proposed appointment, was




opposed to the idea, as several Boers had been seen on the neighbouring kopjes during the afternoon, but he at last consented.

A bundle of telegrams for despatch was handed to the operator, and, accompanied by a cavalryman who had lost his horse and had shared the Cape cart with him, he led his ponies along the "lines" in the direction of the telegraph wire. On reaching the outskirts of the camp the cavalryman proposed that he should visit the outpost groups who were on guard duty not far off, to warn them and to obtain the countersign. He had hardly gone when a light appeared in the direction where the instruments had been left, and the sapper's mind was perturbed as he thought of his apparatus being commandeered by brother Boer. It appeared a long time before his companion returned to tell him that the outposts had also been watching the mysterious light. The two young soldiers conversed in whispers as to a possible explanation. They hesitated as to whether they should advance or return to the camp. The light flashed once or twice and then disappeared altogether, so they decided to proceed. They drove on slowly, and each in turn descended from the cart at intervals, and lying flat on the ground scanned the dark outline of the horizon. Nothing more was seen of the light, yet both suspected that some Boers could not be far off. The horses appeared to scent danger, for they raised their ears as if listening to sounds which were not perceptible to the men. The soldiers knew they must come upon the line at some point, but it was necessary that they should reach the spot where the apparatus had been left.

It seemed hours before they found themselves under the line, and making for the nearest pole they descended to find no trace of instruments or tap lead. The Sapper slung his bandolier over his shoulder, and with loaded carbine in hand he followed the route of the line towards the right, examining the ground at each pole. It was the rainy season and the journey was not made easier by the swampy holes into which he sank knee deep, nor by the ant-hills over which he stumbled every few steps. After a fruitless search of half a mile he retraced his steps to learn that his companion had proceeded with the Cape cart in the opposite direction but without success. However, they determined to search further towards the left, and ultimately came upon the lost instruments all intact. A screen to shield the dim candlelight on three sides was soon improvised by means of an overcoat, and seated on the veldt with a battery box as a desk the operator called "/\/ /\\ /\" on his buzzer. He learnt then that it was nearly ten o'clock, almost three hours since they set out from camp. Messages were soon being despatched and all going well, when the ponies again showed signs of restlessness as if someone were approaching. The light was quickly extinguished and both men lay flat on the ground. Soon they heard the noise of mounted men and were surprised to see some twenty or thirty Boers ride past within a hundred yards of them. The ponies remained silent, in fear, and the khaki-clad soldiers were relieved to find that they were unobserved, and to see the cavalcade disappear again into the darkness. Five minute later the candle was lit again, and when the final message was received no time was lost in packing up and returning to the now slumbering camp. It was a wild drive. Ant-hills and deep holes were ignored, and the horses galloped without requiring encouragement or persuasion. The camp was reached in safety, and the two adventurers were congratulating themselves on their night's work when they found themselves unceremoniously pitched on the ground, along with instruments and provision tins.

It was a three-foot ant-hill. Happily no bones were broken, and after replacing the Cape cart on its wheels again and collecting their property they drove more cautiously to the major's tent. Rousing him out of bed and delivering the despatches, the sapper and his companion unharnessed and tied up their ponies and went off to bed.

J. H. B.

# THE HOLDING-POWER OF A SMALL WALL-BRACKET.

By John H. M. Wakefield.

It was recently found necessary to make the following experiments to determine whether a bracket would be pulled out of a wall when a certain stress was applied in a line with the length of the bracket.

## Experiment 1.—Bracket in Cement.

A small wall bracket fitted with an insulator and spindle was fixed in cement in a fairly old brick wall and left to set for a week. A 200 lbs. G.I. wire was then suspended from the insulator across a yard on a level, and in a line, with the length of the bracket. A stress was applied gradually by means of a tension ratchet at the other end of the wire, and the spindle took up a "set" at 400 lbs. The stress was increased to 550 lbs., but there was no sign of any outward movement of the bracket.

## Experiment 2.—Bracket Wedged in.

A similar bracket was hammered into the same wall and a wooden wedge fitted on each side of the bracket. Stress was applied as in Experiment 1, and a slight outward movement of the bracket was noted at 450 lbs. At 500 lbs. the movement was not appreciably increased.

## Experiment 3.—Simple Drive.

A similar bracket was driven straight into one of the vertical joints of the brickwork, neither cement nor wedges being used. At 500 lbs. the spindle took up a "set." At 550 lbs. no appreciable difference was noted, and the bracket did not seem to have taken any outward move.

EXPERIMENT 4.—POINT OF APPLICATION OF STRESS ALTERED.

The conditions were the same as in the last experiment, except that the 200 lbs. G.I. wire was passed round the eye of the bracket, the insulator spindle being removed, thus altering the point of application of the load, as in the case of a "J" cupholder. A stress of 550 lbs. was registered, but no outward movement of the bracket could be observed.

BREAKING AND WORKING STRESSES OF WIRES.

The minimum breaking stresses of the wires usually fixed to small brackets and the maximum stresses to which they should be subjected are as follows :

| | Minimum breaking stress, lbs. | Maximum working stress, lbs. |
|---|---|---|
| 40 lbs. bronze | 197 | 66 |
| 100 ,, copper | 330 | 80 |
| 70 ,, bronze | 345 | 115 |
| 200 ,, G.I. | 620 | 135 |
| 400 ,, ,, | 1240 | 270 |

CONCLUSIONS.

In the case of Experiment 2 it is doubtful whether the same driving force was applied as in the other experiments, hence the lower reading.

It will be observed that the first "effect" was noted at 400 lbs., when the spindle took up a "set." As this stress is above the minimum breaking stress of the first three gauges of wire mentioned, the experiments would appear to show that in the case of 40 and 70 lbs. bronze and 100 lbs. copper wire the wire would break before the spindle took up a "set," and that in the case of the 200 and 400 lbs. G.I. wire the spindle would take up a "set" before the bracket showed signs of being pulled out.

It is therefore clear that if a small bracket is properly driven into a good wall there should be very little risk of it being pulled out if the above-mentioned classes of wire are used, even if the maximum working stress is applied.

Much depends upon the age and thickness of the wall, and whether the bricks are in mortar or cement. The use of cement to fix the bracket means a second visit to run the wire after the cement has set. It is therefore much cheaper to use the simple drive if the wall is a good one.

# REMINISCENCES OF OVERHEAD AND UNDERGROUND TELEGRAPH WORKS.

By G. W. Hook,
Superintending Engineer, South Midland District.

(*Continued from p.* 117.)

I very well remember the day when the first specimen of lead-covered cable was sent across to our offices at Mount Pleasant by the Chief (now Sir William Henry Preece). My late respected Superintending Engineer, Mr. Eaton, did not look upon it with any favour, and told me that if that was a specimen of what we had to handle in the future he was not sorry he was near his retirement.

This was the Fowler Waring four wire solid core cable, and being the officer in charge of the underground work of London at the time it fell to my lot to deal with it. We had to draw six of these into a line of pipes from T.S. to the Stock Exchange Office in connection with the London-Paris telephones. The route was *via* St. Paul's Churchyard, Cannon Street, and St. Swithin's Lane, and this being quite a new departure in underground work, I felt it incumbent on me to be with the men to supervise the work. All those who are acquainted with the City of London will recognise that the thoroughfares I have mentioned are very congested and busy in the daytime. I therefore decided to carry out the work at night-time, particularly as I intended to attempt to draw the six cables in at one time, which meant six drums occupying the footway. The first attempt was disastrous, the cables jamming. I then tried three at a time, but found that the cables twisted over each other in the pipes, and the same thing happened with two. We tried every means we could think of to keep the two cables in their proper position, but failed. We then determined to draw the cables in one at a time, and I borrowed some sweep's rods for the purpose from the City of London Electric Light Co. This proved satisfactory, and each cable kept its position throughout. This operation of pulling in lasted a week. I think it was the hardest week's work in my life, but the experience gained was valuable. I left home at 11 p.m., worked in the streets directing the men till 7 a.m., then went to an early coffee house for breakfast, after which I went to the office, had a wash, and attended to my ordinary duties until 4 p.m., when I went home and to bed.

This work was carried out in the latter part of June. The weather was splendid, and although I am a Londoner and have spent my life in London, with the exception of the last few years in Birmingham, I never before imagined that London City was so beautiful and imposing as I saw it in the early hours of those few summer mornings, when I was out on the cable work. I took some provisions with me, and sat on the steps leading up to Cannon Street Railway Station one morning about 3.30 to eat a meal, and was struck with the beautiful azure-blue appearance of the atmosphere, and the dome of St. Paul's Cathedral looked magnificent through it. I have not visited Venice, but from what I have read I should think Venice atmosphere would be applicable to London as I then saw it. Presently the rising sun gilded the cross on St. Paul's dome, and then, as the sun rose higher, the azure blue disappeared, and as the fires in the offices, etc., were lighted, the smoke began to rise, and it was the usual old London once more. The next morning at 3.30 I walked down to Blackfriars Bridge and looked up the river. This is the time to see and appreciate that fine old river the Thames. All the buildings on each bank stood out in bold relief, there was that same beautiful blue tint in the air, and the rising sun was gilding the tops of the high buildings, including the Houses of Parliament, while the barges passed silently and slowly along with the tide.

It is quite true London never sleeps. Throughout the whole night there is traffic of some kind. Market carts loaded with vegetables, vans loaded with frozen meat being taken to and from the cold storage warehouses, and, in the early hours, the newspaper vans being rushed from the Press to the different railway stations with horses at full gallop, which I believe is allowed by the police authorities. Another thing which is very noticeable is the number of policemen to be seen about. It would appear as though there were more policemen on duty in the City at night than during the day protecting the valuable property. Cats also are very much in evidence. They all seem to congregate in the streets in the early hours, bent on courting, fighting, or stalking the pigeons.

I will relate here a strange incident which occurred when we were proceeding with the cabling in one of the City streets. It happened that a jointing chamber had been placed just in front of a fruiterer's shop. At about 2.0 a.m. we had the cabling plant and drum of cable drawn up at the shop, ready to proceed with the work, when a man appeared at a window immediately over the shop and ordered us to clear off or he would shoot us. I tried to reason with him, telling him that we should not be long with the work, but he would not be pacified, and with an oath, saying he would fetch his revolver, he disappeared into the room. We came to the conclusion that the man was a lunatic, so we all took to cover in shop doorways, etc., and a police sergeant appeared on the scene just as the man again returned to the window. I told the sergeant what had transpired, and he spoke to the man, telling him to go to bed and not make a fool of himself. It appeared that he was the proprietor of the shop, and on the morning that he had to go to market made it a practice not to go to bed, but to fill in the interval with sundry refreshers. After a little talk he closed the window, the sergeant of police departed, and the work proceeded. Suddenly the gas was lighted in the shop and the man appeared at the door and beckoned to me. I went to the door and he asked me if I was in charge of the work. I said " yes," and that we had almost finished, when he asked me to come inside as he wished to speak to me. I must confess that I did not accept the invitation with alacrity after what had transpired, but as there were no shutters to the shop windows or door, and everything could be observed from outside, I told my foreman to keep an eye on the movements of the man, but to push on with the cabling.

When I got inside, the man said it was too bad making such a noise outside his place, and what made it worse was that his wife had broken her leg that day and was lying in bed in great pain. I said I was exceedingly sorry, and that if he had told me that in the first instance I would have skipped the work in front of his shop. Just at that moment a female appeared at the door leading from the private rooms to the shop, and said, " Now then, when are you coming to bed."

I could see now that the man was a bit wrong in his head, so I wished him good morning, but he would not let me get away until I had sampled some of his special strawberries, and then some fine grapes and peaches. While this was going on the men had finished their work, and in order to give them time to clear away their plant I gave a further proof of my zeal for the Service by eating a few more very fine strawberries, and even then he would not let me come away without a basket of fruit, which he tied up neatly and carefully for me to take home to my wife. He then opened the door and shook hands, and I saw him turn out the gas and disappear through the private door. It was an extraordinary incident, but I must confess the fruit was very nice and refreshing at 2.30 a.m., and later my wife thoroughly enjoyed her share.

To return to the cable, it now became a question as to the jointing. There were no instructions, or past experience of anyone to guide me, therefore as a temporary arrangement, and to allow of the conductors being brought into immediate use for the Paris Telephones extension to the Stock Exchange, I purchased some I.R. hose piping, which was cut into convenient lengths as sleeves, and after the four wires in each cable were insulated and jointed, the sleeves were drawn over the joint and wired at each end. The Fowler Waring Company then tendered to make permanent joints and this was accepted. The method they adopted was to smear the bared core at the joints with a bituminous compound, which was melted and kept in a plastic state by means of a spirit lamp, and when worked down with the fingers sufficiently, the lead sleeve was drawn over the joint and fixed by a plumber's wipe. After some short time the insulation proved to be low, and I came to the conclusion that this had been brought about by the Company's men using a spirit lamp to melt the compound on the conductors. There is a certain amount of vapour in the flame of a spirit lamp which anyone can observe by passing a piece of cooled silvered glass over such a flame, when the glass will be found to be covered with vapour. I assumed that the moisture had been bottled up in the joint and thus had brought down the insulation. I communicated my views to my superintending engineer and the Engineer-in-Chief, and obtained authority to cut out the contractor's joints, and adopt my own method of heating the compound by means of charcoal, which gives a dry heat. For this purpose I had a brazier made, and this was the pattern for those now in universal use in the Service. There being sufficient slack in the cable for the purpose, the old joints were entirely cut out and fresh joints made, by which means the insulation of the cables was restored.

Then followed other types of low capacity lead-sheathed cable, such as the "Fortin-Herman," which comprised four revolving conductors, each conductor being insulated by means of wood beads. These conductors were very loose in the lead sheathing, and in jointing it was very difficult to distinguish the diagonal wires. This really could only be judged by getting the best electrical results. A few of these cables were laid in the Thames Embankment Subway, between Blackfriars and Westminster, but they were not brought into extensive use.

*(To be continued.)*

# NEW COMMON BATTERY EXCHANGE AT CARDIFF.

By T. Devereux.

A new common battery exchange, intended for the use (until 1911) of the National Telephone Company, is at present under construction at the Cardiff Post Office.

An extension of the building has been made to provide room for the new equipment and for the various offices and dining-, cloak-rooms, etc., for the use of the Company's staff. A separate entrance has been provided in Park Street so that the tenancy of the premises by the Company will cause no inconvenience so far as the presence of the different staffs on one building is concerned.

The Exchange will have a capacity for approximately 10,000 subscribers, an equipment of 4600 being provided at present.

The main distributing frame is situated in the basement, in the same room as the frame serving the Department's existing Common Battery Exchange. A two-position engineer's desk is also provided.

Lead-covered cables, each accommodating 200 lines, convey the subscribers' circuits up the existing chute on their way to the Intermediate Distributing Frame. It will be seen from Plate I that in the same room as the I.D.F. are also contained the line and cut-off relay, meter, and junction apparatus racks and the fuse-board. A lamp cabinet is not included, as the line resistance lamps have been dispensed with. Current from the 24 V. battery passes through the line relay on to the subscribers' "B" line; leakage of current on this line is shown up by the glowing of the subscribers' calling lamp. It will be noticed that a 4 V. tap is not used, and no provision is made for automatically showing up a fault on the "A" line.

The line and cut-off relays are wired from the vertical side of the I.D.F., and are numbered to correspond with the operators' panel numbers.

Owing to a large proportion of the lines being rented by "flat" or "inclusive rate" subscribers, and no record of their calls being therefore necessary, only 2300 Service meters have been provided, and these are wired by means of 21-wire cables to 100-tag connection blocks fixed at the top of the vertical side of the I.D.F. Single "jumper" wires will be run from the "test" tag on the horizontal side to these blocks in the cases of the subscribers' circuits requiring the use of meters. On circuits having no service meters, the operator's meter will be sensitively adjusted to operate through the cut-off relay.

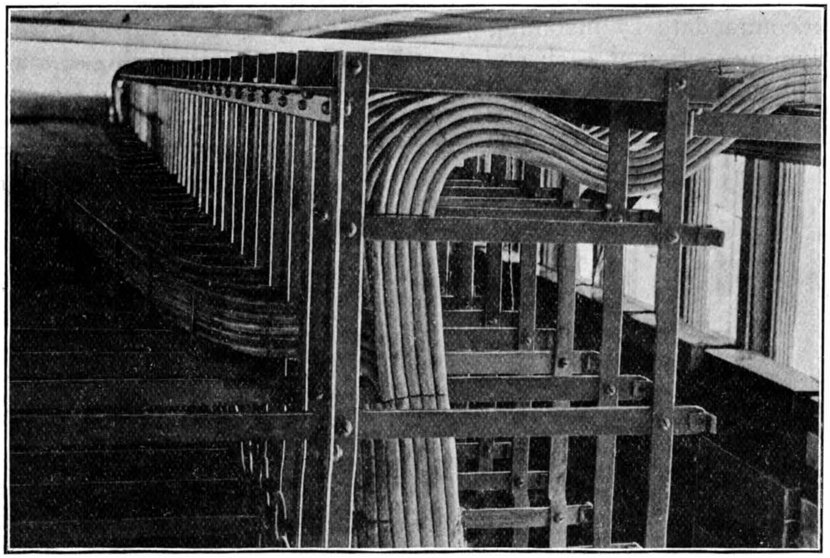
The "A" positions in the switch room comprise twelve 9-panel sections, with a 3-panel "dummy" section at each end. The answering positions have a capacity for 50 jacks and lamps per panel, the present equipment being 40 per panel, so that each position will accommodate 120 subscribers.

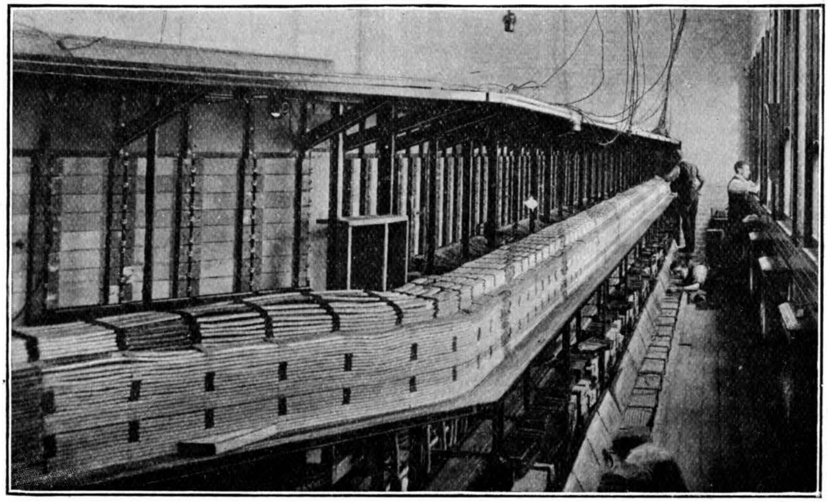
The out-going junction shelf has capacity for 600 lines, with an equipment of 100, multipled every six panels, and the subscribers' multiple comprises 4600 lines multipled every eight panels.

The last operator's position is fitted as a testing position, the test and plugging-up lines connected with the engineer's desk being terminated upon it, while it is also equipped with a volt-meter for testing purposes, and a howler to gain the attention of subscribers who may have left their receivers off the hook.

The subscribers'-operators' cord circuit is very similar to that shown in Fig. 8 of the article on "Common Battery Telephone Transmission Systems, etc.," in the April issue of this JOURNAL, the difference, as will be seen on reference to Plate 4, being that the supervisory relays and retardation coils are each wound to 50 ohms,

TOP OF I.D.F., SHOWING ANSWERING CABLE-RUN AND CABLES FROM VERTICAL SIDE GOING TO LINE AND CUT-OFF RELAYS.





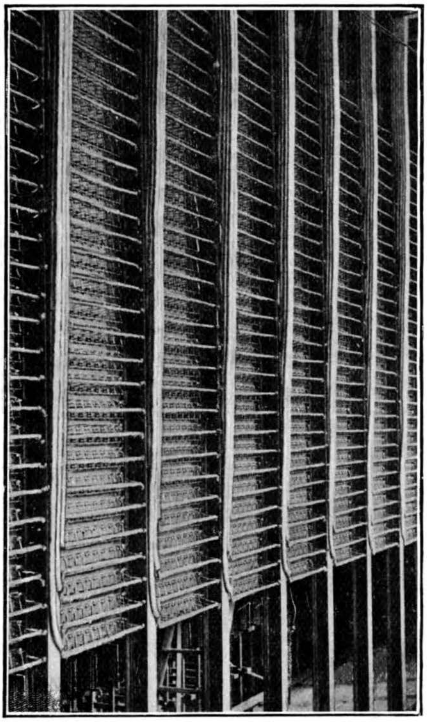
VIEW OF PORTION OF MULTIPLE SHELF, SHOWING CABLES AFTER COMPLETION OF CLAMPING.

I

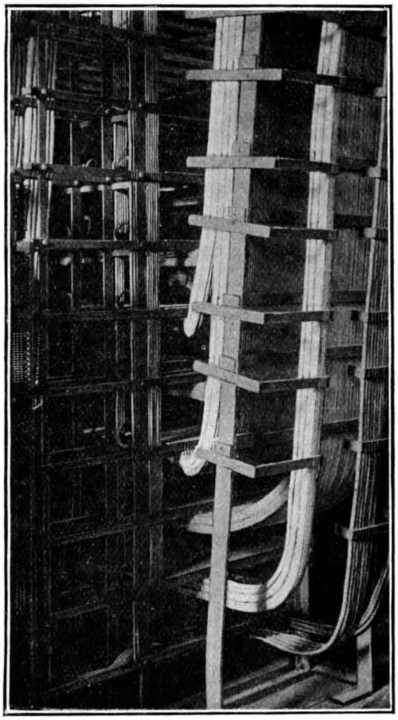
and that their relative positions in the "A" and "B" lines are reversed. It is found that the reduction in the windings of the coils brings the circuit fully in line with that of the Western Electric

Company as regards speaking efficiency on lines with low resistance in the transmitting circuit, and that as regards reception the alteration has the effect of slightly improving the already high efficiency of the Helsby circuit.

On the junction side two 3-position sections (each position to accommodate 27 incoming junctions) are provided, with a 2-panel dummy section at each end, together with a cable-storing section. The junction sections are wired for 81 trunk junctions, 27 magneto-



Wiring of Line and Cut-off Relays.

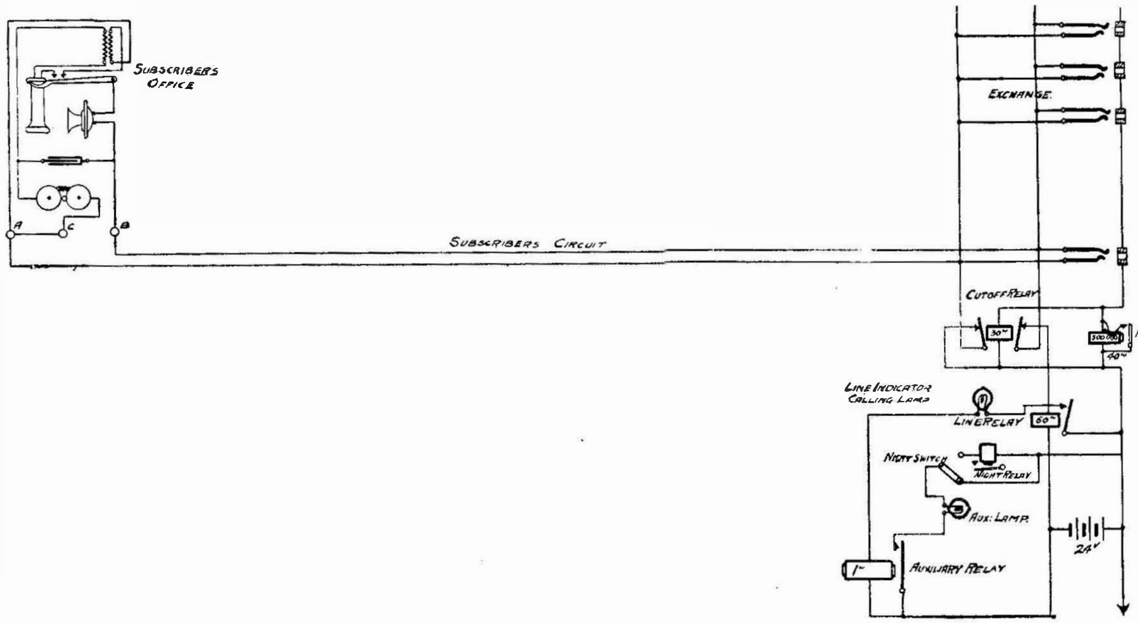


View of I.D.F. showing Multiple Cables leaving Frame.

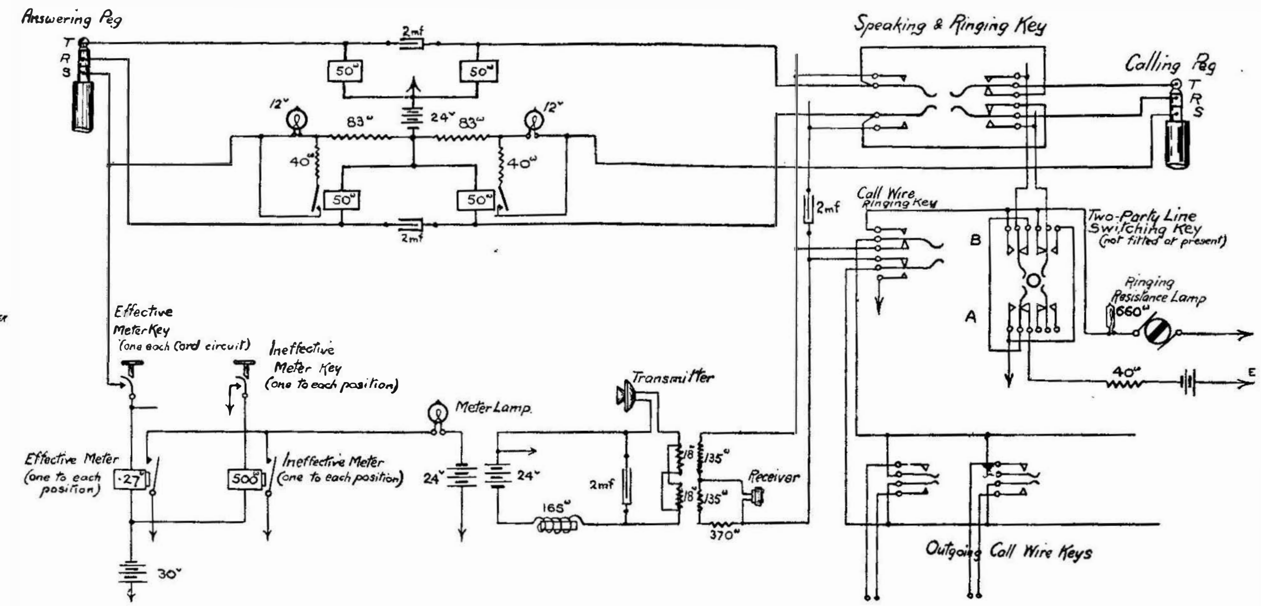
2

junctions, 42 both-way junctions, and 12 junctions incoming from the Department's existing Exchange in the same building. The subscribers' lines and the outgoing junctions are multipled on this side every six panels.

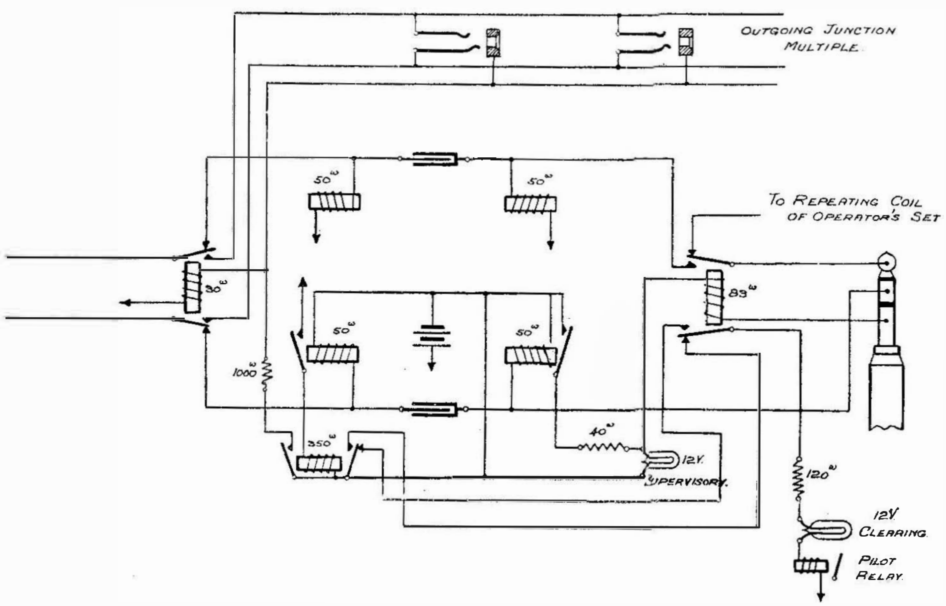
A brief description of the "two-way" junction circuit may be interesting. The lines will be multipled on the outgoing junction multiple on both sides of the room, while they will also be joined to the "B" positions for incoming calls. It will be seen on reference to Plate 5 that the outgoing portion of the circuit is completed through the armatures of the 30ω cut-off relay, which is actuated on



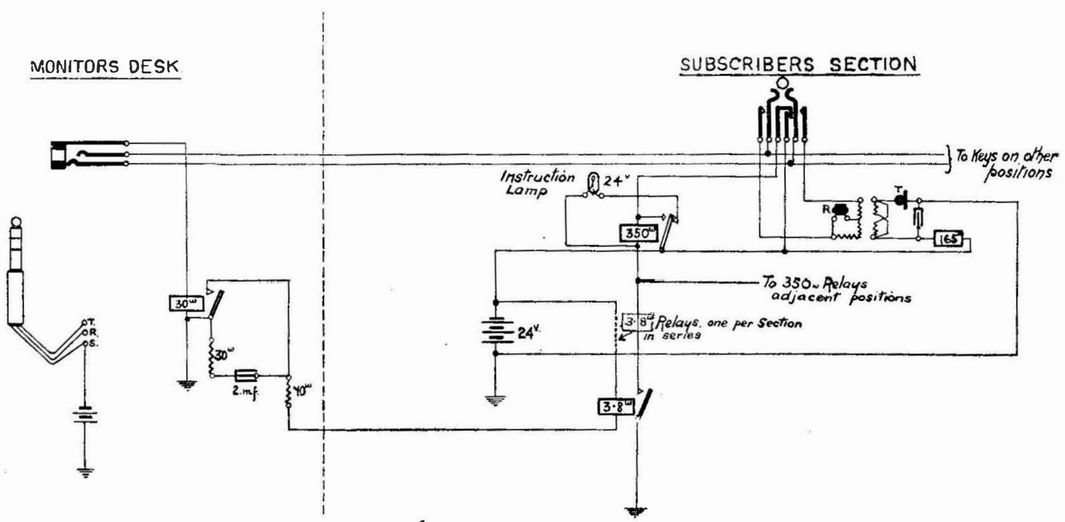

3.—CONNECTIONS OF SUBSCRIBERS' CIRCUIT.




4.—CONNECTING CORD AND OPERATORS' SPEAKING AND METER CIRCUITS.



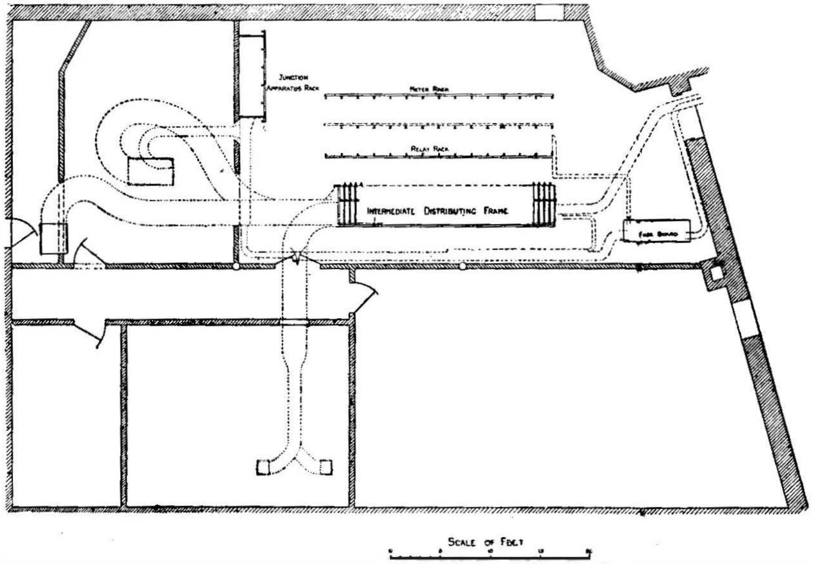

5.—EXPLANATORY DIAGRAM OF 2-WAY JUNCTION CIRCUIT.




6.—INSTRUCTION CIRCUIT.

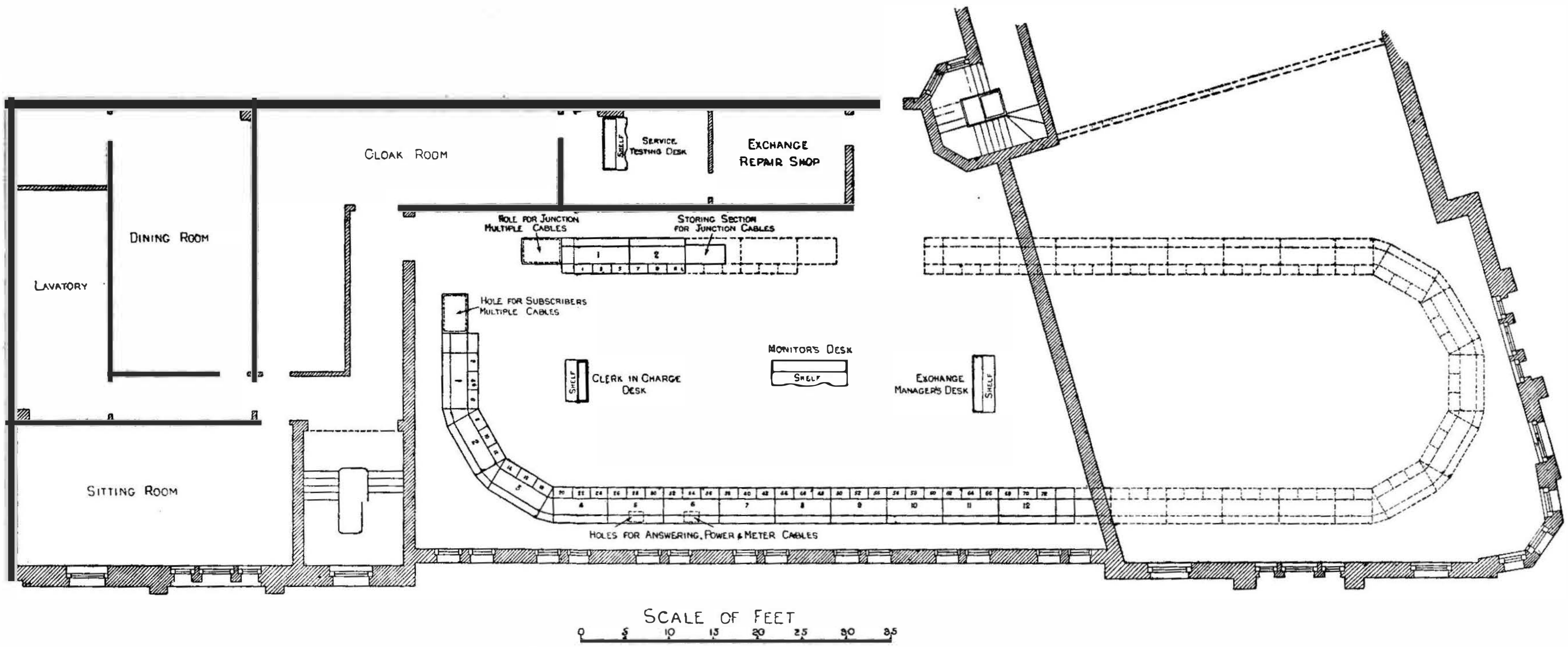
## CARDIFF EXCHANGE.

**I.**




Plan of Apparatus Room First Floor

**2.**




Plan of Switch Room. Second Floor.

**CARDIFF EXCHANGE.**

the junction being taken up for an outgoing call, while at the same time the apparatus on the incoming junction position is cut out. If, however, the circuit is being taken up for incoming purposes the engaged test is put on the outgoing junction multiple bush through the $1000^{\omega}$ resistance spool and the left contact of the $350^{\omega}$ relay. The current flowing through the $1000^{\omega}$ coil and the $30^{\omega}$ relay is not sufficient to actuate the latter, and the normal connections of the incoming side are thus retained. It will be noticed that two pairs of supervisory relays and retardation coils are required for each circuit, the one pair being used solely for signalling to the incoming position from the distant Exchange, which in this case will be worked magneto, and the other pair for the usual supervisory purposes.

Desks for the chief operator, exchange manager, and monitor, the two latter each with two positions, are provided, the wires to the desks being conveyed in 42-wire lead-covered cables run in W.I. pipes laid in the floor.

The monitor will be provided with an instruction circuit to the "A" positions, by means of which conversation can be effected with all the operators simultaneously (see Plate 6). The monitor on pegging in earths the sleeve of her peg through the $30^{\omega}$ cut-off relay, and thus allows battery to flow in series through the $3{\cdot}8^{\omega}$ relays, one of which is provided for each section. The pulling up of this relay completes the circuit of a lamp on each of the three operators' positions at each section. This lamp is provided with a green cap. Each operator on receiving the glow depresses a spare call-wire key to which the instruction circuit is wired, and by so doing brings her telephone across the line, and at the same time, by means of the two special springs, completes the circuit of a $350^{\omega}$ relay and cuts off the lamp. The operator then listens to the instruction which the monitor requires to give, the circuit being again normal on the call-wire key being released and the peg withdrawn at the monitor's desk.

The Exchange will be run from the existing power plant, with the exception that sufficient plates will be added to the two sets of secondary cells, which are at present only partially fitted, to bring them up to their full capacity of 3060 ampère hours at the 9-hour rate. Separate ammeter shunts will be provided for the 24 V. and 30 V. battery leads to permit of the amount of current taken to work this Exchange being measured.

An extensive scheme of underground work is being carried out in conjunction with the Exchange equipment, a description of which, however, cannot be attempted here.

The writer has to acknowledge his indebtedness to the British Insulated & Helsby Cables Limited, who have been entrusted with the carrying out of the Exchange equipment, for the copies of diagrams, etc., accompanying this article.

# DEVELOPMENT OF THE POST OFFICE LONG-DISTANCE TRUNK EXCHANGE SYSTEM. (A) TRAFFIC.

By J. Stuart Jones.

An analysis of the particulars relating to the long-distance telephone service of the United Kingdom, which have been published in the Annual Reports of the Postmaster-General during the past eleven years, that is, since the acquirement by the State of the trunk lines of the National Telephone Company, furnishes much interesting evidence of the great development of this branch of the public service. The number of calls made during the twelve months ending March 31st, 1898, was 5,888,247, while the number made during the twelve months ending March 31st, 1908, was 21,993,113, an increase of 273·5 per cent. during the ten years. The revenue for the year ending March 31st, 1898, was £133,974, and for the year ending March 31st, 1908, £535,104, an increase of 299·4 per cent. during the ten years. The most significant testimony to the well-being of the service is, however, the great improvement which has been effected in the annual number of calls carried, and the annual revenue earned, per mile of circuit, in spite of the fact that during the past ten years the mileage of the system has increased three-fold. The actual figures year by year are as follows:

| Year. | Circuit mileage. | Number of trunk conversations. | Revenue. | Average number of calls per mile. | Average revenue per mile. |
|---|---|---|---|---|---|
| | Miles. | | £ | | £ |
| 1897–98 | 27,860·5 | 5,888,247 | 133,974 | 211 | 4·80 |
| 1898–99 | 31,554·5 | 7,066,609 | 167,505 | 223 | 5·30 |
| 1899–1900 | 34,856·5 | 8,091,631 | 191,701 | 232 | 5·49 |
| 1900–01 | 38,415·5 | 8,980,733 | 211,209 | 233 | 5·49 |
| 1901–02 | 41,651 | 10,080,716 | 238,720 | 242 | 5·73 |
| 1902–03 | 46,736·5 | 11,574,229 | 274,835 | 247 | 5·88 |
| 1903–04 | 51,399·5 | 13,467,975 | 325,525 | 262 | 6·33 |
| 1904–05 | 56,371·5 | 15,461,822 | 380,308 | 274 | 6·74 |
| 1905–06 | 64,031·5 | 17,974,039 | 449,003 | 280 | 7·01 |
| 1906–07 | 70,905 | 19,803,363 | 480,658 | 279 | 6·77 |
| 1907–08 | 79,676 | 21,993,113 | 535,104 | 276 | 6·71 |

Many things have contributed their share to this result. The switchboards and the other mechanical appliances of the system have been gradually improved, and the efficiency of the operating staff has steadily risen; but the chief factor has been the alteration, almost amounting to revolution, in operating methods, which has been effected during the past four years. Obviously in such a system as the trunk telephone service it becomes increasingly difficult year by year to raise the output per circuit mile, and the fact that the years showing the most rapid rate of growth were those in which the operating methods were largely altered is a proof of the efficacy of the changes. These changes enabled the existing circuits to carry additional traffic, to accommodate which it would otherwise have been necessary to erect more lines at heavy capital expenditure. The reduction in the circuit-mile averages for the last two years of the period arises from a check in the growth of traffic during those years as compared with the year 1905–6. The growth during that year was very great, and, in consequence, with a view to meet further development, the construction of a large number of additional lines was commenced. The development has not, however, been so rapid as was anticipated.

The fountain-head of all the improvement was the Telephone Call Wire, which was introduced in connection with the London-Liverpool trunk lines about the middle of 1904. Prior to that time all communications passing between the trunk-line operators at different towns and relating to the calls about to be effected were made over the trunk-lines in the intervals between the conversations of subscribers, and the lines had necessarily to lie idle while the attention of the subscribers was being gained. So much of the time of the lines was occupied in service communications and so much unavoidably wasted that it was not often that a circuit carried more than ten 3-minute calls in an hour, even during periods of pressure. After some experiments as to the possibility of introducing in connection with the trunk lines some system of down-call wire working similar to that largely in use for junction work between local exchanges, it was arranged to set aside one of the trunk wires between London and Liverpool for purely service purposes. An operator was continuously in circuit at each end of this service or call-wire, and all service communications between the two exchanges were effected exclusively through the medium of these operators. The trunk lines used for carrying public calls were in this way relieved of service work, and it also became possible, through the agency of the call wire, for the particulars of the subscribers required to be passed from one town to the other slightly before the calls matured. The operators were thus generally able to secure the attention of the subscribers a few seconds before a trunk line became disengaged, and were able to place the subscribers in communication with each other immediately the line became available. The periods of idleness inseparable from the previous method of operating were in this way largely reduced, and the carrying capacity of the trunk lines was, in fact, so increased that during busy periods each circuit of the group usually carried fifteen calls in an hour instead of the ten which had previously been the limit, while not infrequently even better results were obtained.

The success of the London–Liverpool Telephone call-wire led to the introduction of similar call-wires at many towns where there were suitable groups of lines, and at one time about thirty such call-wires were in existence. The telephone call-wire had, however, the disadvantage that it withdrew a trunk line from the directly revenue-earning work of carrying public calls, and this disadvantage has led to the general substitution of telegraph call-wires for telephone call-wires. It was at first proposed to use telegraph wires as call-wires where possible, as, being single-wire circuits, they would cost less to maintain than the double-wire telephone circuits ; but a telegraph call-wire between London and Manchester which was obtained, towards the end of 1904, by superimposing Morse apparatus on one of the trunk lines, without appreciably interfering with the normal functions of the circuit, proved so successful that all telegraph call-wires are obtained in this manner. The system has been much extended and at the present time about 150 groups of circuits are worked by call-wire. It has sometimes been argued, in view of the complications introduced by telegraph working in connection with the telephone system, that it would be quite as economical to obtain *telephone* call-wires by superimposing. This is true enough, but a superimposed telephone circuit, which is efficient enough for use as a call-wire, is also good enough for use by the public, and the waste of revenue-earning power is, therefore, the same whether the telephone call-wire is a superimposed or a metallic circuit. A few telephone call-wires are still in existence, but in these cases spare wires in telephone cables are available for the purpose.

The benefit of call-wire working, for some time after it was introduced, was, however, confined to expediting the handling of direct town-to-town traffic, that is, of calls effected by means of the call-wire group only. It was of little service for expediting calls involving the combination of two or more trunk lines. The usefulness of the call-wire in enabling subscribers to be called in advance of their calls maturing on the trunk lines had full scope in the case, for example, of a call between subscribers in London and Liverpool. The operators at each town had practically the same work to perform ; they knew when a trunk line would become disengaged, and they were thus able so to shape their movements as to place the subscribers in communication with each other with the least possible waste of time. The call-wire, however, failed to be of service when the call was between London and a town beyond Liverpool. If a London subscriber wished to speak to a subscriber at Southport, for example, the particulars of the call could of course be forwarded in advance by the London operator to the Liverpool operator and by the latter transmitted to Southport, but it would have been out of the question for the Southport operator, in the absence of knowledge of the conditions of the London–Liverpool service and of the precise time at which a line would be free, to have obtained the attention of the Southport subscriber; and it would have been equally out of the question in the circumstances for the London operator to have obtained the attention of the London subscriber in anticipation of the call maturing. It was therefore the practice, in the case of such a call, to extend a London–Liverpool circuit to Southport; the London operator would then pass to the Southport operator over the trunk line the particulars of the subscriber required, and the line would lie idle while the attention of the subscriber was being gained. In fact, the call was practically operated in the manner followed prior to the introduction of call-wire working, and the benefit of the call-wire was lost. Obviously, in the case of those trunk services where a considerable proportion of the calls involved an intermediate switching, the usefulness of the call-wire was largely nullified, and the question arose whether it would not be possible in some cases for the intermediate exchange to obtain the attention of the subscriber in the terminal town in advance of the maturing of the call on the call-wire group, precisely as in the case of a local subscriber; that is to say, taking the case of a London–Southport call again as an example, whether it would not be possible for the Liverpool operator to obtain the attention of the Southport subscriber in advance of the maturing of the call on the London–Liverpool lines. The Liverpool operator would, of course, know when the call would mature on the lines to London, and she would thus be enabled so to arrange her movements as to have the Southport subscriber in readiness at the proper moment. The arrangement, if practicable, would clearly economise the time of the London–Liverpool lines.

In this idea lay the germ of the method of operating known as zone working, which has since been developed and is now in operation throughout Great Britain. It was evident, at the commencement, that it would be essential that the powers to be vested in the intermediate exchanges should be operative only within definite areas and limited in application to certain services. If the lines between the intermediate and the terminal exchanges were to act as feeders of the circuits forming the call-wire group, it was clear that, in order to secure a proper relation between the two classes, the former should consist of short lines radiating from the intermediate exchanges, while the call-wire groups should consist of the longer and more important circuits. The system of working outlined was accordingly introduced in connection with the London–Liverpool, London–Cardiff, Liverpool–Birmingham, and a few other call-wire groups, all the short trunk lines radiating from Liverpool, Cardiff, Birmingham, etc., being defined as the area or zone of operation in each case. The London telephone area was, in the first instance, regarded as the London zone, but this zone has since been extended. The arrangement proved so satisfactory in improving the working of the call-wire groups where it was tried that it was decided to make the practice general. The country was divided into forty-three zones, the arrangement of which was based on the geographical disposition of the various trunk exchanges, and the leading commercial town of each zone was selected as the zone centre. Where the lines between zone centres were too few to form a group for call-wire working, it was arranged to operate them by the method known by the somewhat cumbrous title of "continuous attention." This method of operating, in essence, means that the number of circuits under the control of one operator is so reduced that she is able to keep the transactions under more continuous observation than is possible when she has a normal complement of lines. The operators working such lines are enabled to pass to each other the particulars relating to each call before the call actually matures, and, by attending to the calls in proper sequence, are generally able to obtain the attention of each subscriber before a trunk line becomes disengaged.

All the circuits between zone centres, *i.e.* all the important long-distance lines, are therefore now worked either on the call-wire or the continuous attention system, each zone centre being responsible for obtaining the attention of subscribers at any town within its zone who are required for calls to be effected over lines to other zones.

Lately a further extension of the system has been made. The zone centres, in addition to obtaining the attention of the subscribers, now time the periods of conversation and generally supervise the calls, this work having previously been performed at the originating exchange in each case. The operators at the zone centres are in this way enabled to keep a closer check on the working of the important lines under their charge.

In addition to raising the output of the more important trunk lines, zone working has brought several other benefits in its train. It has enabled the circulation of calls to be simplified; it is contributing to the formation of new call-wire services between zone centres and the minor trunk exchanges of the zones, and it has an important relation to the question of economy in engineering construction.

The introduction of zone working has been too recent for much data to be gathered to show its general effect in raising the circuit-mile averages referred to in the earlier part of this paper. There is much evidence to show that its introduction has led to a much quicker long-distance service, yet it is a curious fact that the short lines, *i.e.* the within-zone lines, have not suffered so seriously as might have been expected. The return which is given below of the Glasgow–Greenock working for one day in January, 1908, is of significance. In two consecutive hours the revenue minutes, *i.e.* the time for which subscribers paid, amounted to 46 minutes and 43 minutes per circuit respectively. When it is remembered that the path is not always clear for trunk calls, that subscribers may be engaged locally, that they may be engaged on other trunks, that junction circuits may not be immediately available, that 1½ minutes may be lost in ringing subscribers in those cases where prompt attention is not given, to obtain 43 or 46 minutes revenue out of the total of 60 is no inconsiderable achievement. Short-distance lines, such as the Glasgow–Greenock lines, are liable to be held for the longer distance lines in order that more valuable time may not be lost on the latter. This adds to the excellence of the results shown in the return.

*Return of Traffic dealt with on Glasgow–Greenock Trunk Circuits Nos. 1, 2, and 3, on January 21st, 1908, for each Hour from 8 a.m. to 8 p.m.*

| Time. | Circuits. 1. No. of calls. | 2. No. of calls. | 3. No. of calls. | Total. | Average per circuit. | Maximum delay. |
|---|---|---|---|---|---|---|
| 8– 9 a.m. | 6 | 4 | 1 | 11 | 3·6 | No delay service |
| 9–10 „ | 7 | 6 | 2 | 15 | 5 | |
| 10–11 „ | 12 | 17 | 17 | 46 | 15·3 | |
| 11–12 noon | 14 | 13 | 16 | 43 | 14·3 | |
| 12–1 p.m. | 12 | 10 | 12 | 34 | 11·3 | |
| 1–2 „ | 10 | 7 | 9 | 26 | 8·6 | |
| 2–3 „ | 12 | 10 | 7 | 29 | 9·6 | |
| 3–4 „ | 15 | 12 | 14 | 41 | 13·6 | |
| 4–5 „ | 11 | 12 | 13 | 36 | 12 | |
| 5–6 „ | 4 | 3 | 3 | 10 | 3·3 | |
| 6–7 „ | 6 | 4 | 2 | 12 | 4 | |
| 7–8 „ | 5 | 4 | 3 | 12 | 4 | |
| Total | 114 | 102 | 99 | 315 | 105 | |

But even more remarkable are the results on the long-distance lines between zone centres. Every minute lost in operating on the London–Liverpool lines is worth eightpence, hence the importance of very close operating so that no time may be lost. Returns are taken for one day monthly for every circuit worked by call-wire or continuous attention, and they show a steady improvement. The latest returns show a revenue-time in the busiest hour of 47 minutes on the Leeds–Liverpool route, of 46 minutes on the Liverpool–London route, of 49 minutes on the Birmingham–London route, and of 50 minutes on the Birmingham–Cardiff route. This has a remarkable bearing on the efficiency of the routes in respect to delay, for not only does it mean that better revenue is obtained, but that the work is disposed of with a better flow, and the delay is consequently less. Of course, this method of working is only in its infancy, but it is evident that it will be fruitful of good and that the future development of the service in respect to promptness of connection will offer results of which we can only dream at present.

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# DEVELOPMENT OF THE POST OFFICE LONG-DISTANCE TRUNK EXCHANGE SYSTEM. (*B*) ENGINEERING.

By W. J. Medlyn.

Prior to the transfer of the telephone trunk lines to the Post Office in 1896, the magneto generator call and clear system was in general use by the National Telephone Company for the local exchange services in this country, and it was perhaps natural that the trunk lines should be worked on the same plan.

On the purchase of the lines by the Post Office, however, it was decided to introduce a system of automatic signalling, and switchboards each capable of accommodating a maximum of five trunk circuits were designed. Each trunk circuit was connected through a jack to a line calling relay, and with the latter a separate battery consisting of nine Leclanché cells was associated.

Six pairs of 2-conductor pegs and cords were provided for each switchboard, and across the two conductors of each pair a magneto indicator of the self-restoring type ($1000^{\omega}$) and a galvanometer ($1000_{\omega}$) were joined in series for the receipt of clearing and supervisory signals. One speaking key and two ringing keys were also provided for each pair of pegs and cords.

The general principles of the method of signalling may be explained briefly by saying that the line batteries at each end were joined up in opposition, so that normally, with perfect insulation of the wires there was no current flowing through the line coils of the relays. When a peg was inserted at one end of the line, the relay and battery were cut off and a path was opened for a current to flow from the battery through the relay at the distant exchange, through the line, and through the indicator and galvanometer associated with the cord circuit. The call was thus given automatically, the result being indicated to the distant operator by the deflection of a needle on the front of the relay, and, when necessary, by means of a local bell in the armature circuit of the relay. In order to counteract the effect of line leakage which might result in the giving of false calls, three of the nine cells already referred to were joined up in a shunt circuit, so as to keep the needle of the relay normally deflected to the right and the armature held against the back stop. The working margin of the relay was somewhat small, however, especially on the long lines, and in order to ensure the receipt of calls it was necessary to have a ringing battery key associated with one peg of each pair of cords. The ringing battery consisted of ten Leclanché cells, and the connections were such that when the key was depressed the battery was joined up to assist the action of the automatic battery at the distant exchange.

Junction circuits were provided between the Post Office and the local exchange, generally at the rate of one junction for every trunk circuit.

In the largest centres a subscriber of the National Telephone Company requiring a trunk connection passed the necessary particulars to the Company's operator, and the latter repeated the particulars to a Post Office operator over a call wire upon which the latter was continuously listening. The particulars of the call were recorded upon a ticket which was afterwards circulated to the operator controlling the trunk line concerned. In the smaller centres the particulars of the calls were repeated over a service circuit, the attention of the Post Office operator being gained when necessary, by ringing. When a trunk line was at liberty the trunk operator selected the junction circuit to the local exchange, requested the local exchange operator to extend it to the subscriber requiring the connection, and proceeded to call the subscriber by means of the magneto ringing key associated with the pair of pegs and cords in use. At the same time, the trunk operator took steps to obtain communication with the distant exchange subscriber.

On conclusion of the conversation the local subscriber rang off (or was expected to do so), thus dropping the shutter of the indicator at the trunk exchange. On the withdrawal of the connecting pegs the automatic calling battery was applied to the trunk circuit, thus causing a current to flow through the galvanometer associated with the pair of pegs and cords in use at the distant trunk exchange, and giving an automatic clearing signal.

When the conversation was finished, the trunk operators were required to verbally request the Company's operators to clear the junction circuits, a down call wire or service circuit being used for the purpose.

It must be admitted that the theoretical method of working by automatic signals was not always obtainable in practice. The battery power available was comparatively small and consequently difficulty was generally experienced in maintaining the delicate adjustments of the apparatus. Owing to the shunting effects of the local exchange apparatus, failures of the generator ringing signals to actuate the drop indicator across the trunk exchange cords were frequent, and to overcome the difficulty the coils of the galvanometer in series with it had to be joined in parellel (250 $^{\omega}$). This alteration reduced the effectiveness of the signal from the automatic battery, as indicated on the needle of the galvanometer, and when combined with the shunting effect of other apparatus and the use of long lines, some discrimination was necessary at times to distinguish between the deflection due to current, and the natural hang of the needle.

When more than two and not more than ten switchboards were installed, direct transfer circuits with automatic signalling were provided for inter-communication between the various groups.

When more than ten switchboards were installed a transfer section was necessary for through switching between the trunk lines. In this case an operator at, say, No. 2 switchboard, on being requested to extend one of her lines to another line terminated at, say, No. 11 switchboard, would obtain communication with the later position *via* the transfer section, where an operator was stationed for the purpose of effecting such connections.

In four of the largest exchanges, viz. Birmingham, Glasgow, Manchester, and Leeds, secondary cells were provided for the operators' transmitters and for local signalling on the various indicators within the exchange. At all other exchanges primary batteries were used. At the four exchanges named primary batteries were also used for independent signalling on the trunk lines, as already described—nine cells for each line.

One of the first steps in the direction of improvements was to introduce a battery at the Post Office for sending an automatic clearing signal to the local exchange operator on the withdrawal of the connecting peg from the junction line jack.

With the growth of the system it soon became evident that at the large exchanges the use of primary batteries for line signalling would be a serious tax on the building accommodation, and on the maintenance charges, and in 1897, when the writer was in charge of the engineering arrangements at the Leeds Trunk Exchange, he devised a scheme for using secondary cells on the "Universal" system, in place of the independent primary batteries for line signalling. This resulted in the recovery of close upon 1000 cells at Leeds, and as the result of the trial proved quite satisfactory, the system was shortly afterwards brought into general use at the other three exchanges.

At other important centres a similar system was introduced by working the line signalling primary batteries on the "Universal" system, *i. e.* one battery was joined up for common use on all the lines in each exchange, thus economising space by reducing the total number of cells.

The switchboards of the original pattern met the requirements when the system was comparatively small, but as the exchanges increased in size engineering and operating difficulties began to manifest themselves. The provision of one junction for every trunk line meant low traffic efficiency in the junction service, because the junction lines could not be worked up to their full capacity. During the maximum load periods trunk lines were, of course, occasionally idle, or were connected together for through traffic, and at such times the corresponding junctions would be left idle. It was necessary, however, to have the junction lines available for use when required, in order to avoid loss of time on the important and costly long-distance trunk lines.

In the London Trunk Exchange the junction circuit conditions were somewhat exceptional, owing to the comparatively large number of important local exchange centres within the area. In this case an effort was made to economise the number of junction lines by terminating them on transfer sections so that a trunk operator could obtain communication with any local exchange only with the assistance of a transfer operator in the trunk exchange. In addition to the junction transfer sections, trunk transfer sections for through switching between trunk lines, as already described, were of course necessary, and ultimately the number of transfer sections began to assume a relatively large proportion to the total number of switchboards in the exchange. The numerous transfer sections necessitated the provision of a very large number of transfer circuits with mechanical indicators and 8-point jacks, which gave rise to maintenance difficulties, while the transfer operations involved some unavoidable delay in completing connections, and also involved the provision of extra operating staff, as well as the occupation of corresponding valuable floor space in the exchange and in the retiring rooms.

In 1903 the accommodation available for the trunk exchange equipment in the Central Telegraph Office (London) was found to be approaching the limit, and it was decided therefore to provide an installation of an entirely new design in more spacious rooms at the General Post Office (South).

The details of the new scheme were worked out under the direction of the late engineer-in-chief of the Post Office, Sir John Gavey, and the order for the plant was placed with the British Insulated and Helsby Cables Company.

The new exchange was opened early in 1904. Full descriptions of the installation were published in 'The Electrician' and the 'Electrical Review,' commencing under the date of February 5th, 1904, but a brief *resumé* of the alterations introduced will no doubt be of interest.

Lamp signalling was employed throughout on the trunk and transfer switches. The trunk line-calling relays were placed on a rack in a separate room, the line-calling lamp being, of course, placed in front of the operator immediately adjacent to the line jack. Lamp signals were also provided for the connecting pegs and cords, the controlling relays being placed inside the switchboard.

Automatic calling on the trunk lines was dispensed with, the operator being required to give a momentary ring from the magneto power generator after inserting a peg into the trunk line jack. Opposing batteries were joined up at each end of the trunk line for giving the automatic supervisory signals on the apparatus associated with the connecting pegs and cords. The junction circuits were multiplied throughout the exchange, one complete multiple being provided for every two trunk operators. The larger groups of junctions were controlled by call-wires, while in the smaller groups a calling signal was automatically displayed at the local exchange when the trunk operator plugged into the multiple. In the latter case a press key, associated with a common lamp controlled by a relay, was multiplied, in addition to the jack, for the purpose of applying the "engaged test."

The calculagraph was also introduced for the purpose of timing the ticket records of trunk conversations. The old system of transfer working for through communications was retained, but space was economised by terminating an increased number of circuits at each transfer switchboard.

In the intervening years the Post Office, in conjunction with the National Telephone Company, had introduced a system of record circuits to enable subscribers to pass particulars of their calls direct to the Post Office operators, thus minimising the risk of error in having such particulars repeated by the local exchange operator under the conditions already described in connection with the method of working which obtained at the outset. Twenty of these circuits as a maximum were terminated on a small switchboard equipped for two operators.

Soon after the opening of the new exchange new methods of handling traffic began to be developed, and the Engineering Department was called upon to devise new arrangements of apparatus and wiring to keep pace with the traffic requirements.

It was found by experiment that if some nine or ten lines existed between any two centres an increase in the carrying capacity of the group resulted by providing an additional operator at each end and giving them one of the lines to use as a service call-wire to control the traffic on remaining lines. The call-wire controlling operators passed particulars of the required connections to each other in advance, and the attention of the subscribers was gained in readiness for connection with the trunk line immediately one became free, thus reducing waste, or non-revenue earning, time to a minimum. By working the lines in this way the traffic over the group as a whole was increased, thus more than compensating for the loss due to the appropriation of one line of the group for service purposes.

The usefulness of the call-wire system having been demonstrated, the next step was to devise a scheme for superimposing a Morse telegraph call-wire on one of the trunks in each group, and thus afford the advantages of call-wire working without reducing the number of channels available for public conversations, and without very materially reducing the speaking efficiency of the trunk circuit used for superimposing. The superimposed telegraph circuit was formed on the "bridge" system, with condensors interposed in the telephone leads so as to prevent loss of current used for telegraphing. Single current working with relays was adopted, the local sounder being constructed of small dimensions, and mounted in a head-gear case similar to that of an operator's ordinary head-gear telephone receiver. Tests of the apparatus showed that the arrangement reduced the efficiency of the trunk lines to the extent of approximately two miles of "Standard Cable."

The telegraph call wire worked very satisfactorily, and in view of the consequent saving of wires the arrangement met with favourable consideration from the outset. In fact, demands for the extension of the system soon became so numerous that for some time considerable difficulty was experienced in obtaining supplies of the apparatus at a sufficiently rapid rate.

It is no doubt well known that with the Post Office system of charging for trunk conversations on the "three minutes" unit, it is necessary to time the ticket records at the beginning and end of each conversation. With the calculagraph this timing is, of course, done by stamping the ticket in the machine, but the operator was required to carefully watch the time of commencement stamped on the ticket, in comparison with the clock, during the progress of the conversation, in order to ensure that the authorised limits should not be exceeded. This procedure involved some loss of time, which it was considered might be usefully employed in more remunerative work, and with this end in view an instrument was designed by the writer to give a warning to the operator automatically at the end of each three minutes period. So far as the operating was concerned, a press-key was associated with each line jack and calling lamp, and when a peg was inserted in the jack the line lamp was arranged so as to be available for the time check signals. At the commencement of the conversation the operator pressed the key, and at the end of three minutes the line lamp glowed. After an extended trial the experiment was found to be satisfactory, and the general introduction of the time check apparatus for lamp signalling exchanges was decided upon.

A technical description of the telegraph call-wire and time-check apparatus was published in 'The Electrician' of June 15th, 1906.

With the rapid growth of the exchange, difficulties in providing for rapid through switching *via* transfer switchboards became apparent, and a demand was made for direct switching facilities to be provided between all the trunk operators. It was evident that independent direct transfer circuits on the old plan could not be provided, chiefly on account of the expensive and bulky apparatus and the somewhat complicated wiring involved. Some difficulty was at first experienced in devising a suitable method for bringing into use in conjunction with the other apparatus in the exchange, but ultimately a special relay was designed and a multiple system introduced. Each trunk operator was given two answering lamps and jacks, the multiples of which were available to every other operator in the exchange. The automatic call system was adopted, the lamp associated with the answering jack glowing when a peg was inserted into the multiple, but the inner contacts of the answering jack were connected to the operator's telephone so that the operator could make a preliminary reply, if desired, without inserting a peg into the jack.

The connections of the operators' telephones were also modified so that the engaged test could be applied to the multiple by the well-known "click" method.

The multiple transfer installation worked very satisfactorily, and the arrangement not only afforded better facilities for through switching, but a saving of operating staff, and valuable floor space was also effected by the recovery of the transfer sections.

The introduction of the "engaged click" test for transfer multiples naturally opened the way for the application of a similar arrangement in connection with the junction circuit multiples, and it was therefore decided to discontinue the use of the engaged test keys which were originally introduced for this purpose.

The keyboard of the trunk switches was originally arranged so that a trunk operator could, if necessary, push over a key and disconnect the local subscriber while she was engaged in obtaining the connection over the trunk line. The connections were subsequently altered so that the operator, by manipulating the keys, could speak to the local "home" subscriber, or to the distant trunk operator independently, without removing either of the pegs from the jacks.

With the development of the system the working of the independent record table switches already referred to began to give trouble owing to the difficulty of providing for an equal distribution of the traffic among the operators. One operator was often temporarily overpressed, while at the same time another operator would probably be idle, the switchboards not being suitably designed for team working. A scheme was, therefore, devised for terminating all the record lines on one distributing switchboard so that the record operators could be utilised to the best possible advantage. The lines were terminated on jacks, each of which was associated with a calling lamp. Each record operator's telephone, upon which she was required to listen continuously at the record table, was connected with a peg and cord at the distributing switchboard, each peg being associated with a clearing lamp. On observing a call, the switching operator selected a disengaged record operator's peg and inserted it into the corresponding jack. This operation automatically lighted a supervisory lamp in front of the record table operator. After noting the necessary particulars on a ticket the record operator was required to press a key to send a clearing signal to the switching operator, who then severed the connection.

The arrangement worked very smoothly and the operating was of such a simple character that an attendant at the distributing switch was able to extend calls to the record table at the rate of from 800 to 1000 per hour.

After the completion of the London Trunk Exchange similar installations were provided at Cardiff and Birmingham, and slight modifications of the same pattern have also been installed at Newcastle-on-Tyne, Blackburn, Oldham, Sunderland and Manchester. Installations similar to the London one have also now been provided at Glasgow, Liverpool and Bradford.

In addition to the introduction of improved apparatus of the lamp signalling type at the large trunk centres, the telegraph call-wire system has been applied generally throughout the country, and various changes have also been introduced in the apparatus equipment at the smaller trunk centres.

In conclusion it may be interesting to quote an extract from 'The Electrician' of February 19th, 1904, where the Editor, commenting on automatic devices in connection with the London Trunk Exchange installation, remarks as follows:

"In the new trunk telephone exchange to which we refer, a successful attempt has been made to produce a common battery luminous signal board, the operating of which is as simple as possible, although it has to work in connection with a number of other exchanges, with calling and clearing arrangements of various degrees of automatism. The result is the most intricate combination of relays and other devices that we have ever seen in a telephone exchange. So far is the principle carried out, in fact, that we should not have been surprised to find on the switchboard a blue lamp associated with an automatic cut-off device to put a subscriber out of circuit should his language exceed the bounds of parliamentary usage."

As in the case of modern local exchange switchboards designed by various administrations, one of the chief objects aimed at in the design of the lamp-signalling trunk switchboard was simplicity of operating, because it was recognised that if this were achieved increased revenue would surely follow. To show that the anticipated results have been achieved as the result of improved apparatus facilities and improved traffic management, it is perhaps only necessary to say that the average number of calls passed over each trunk line throughout the country in 1906 was approximately 50 per cent. greater than the corresponding figures for 1898.

As regards the maintenance of the plant the cost compares favourably with that relating to large common battery local exchanges of the standard type, and in practice the "intricate combination" of the apparatus does not appear to be a serious item.

I may add that at the time the foregoing extract was published, the three-minute time check was under trial experimentally, but it was not considered expedient to bring it into use quite in the manner humorously suggested by 'The Electrician' Editor.

# RICHMOND EXCHANGE—TRANSFER FROM C.B.S. TO C.B. WORKING.

By J. Hedley.

A description of the new C.B. equipment at the Richmond Exchange appeared in the last issue of the Journal, and on Saturday, July 25th, at 3 p.m., the Exchange was brought into use by transferring the working subscribers from the C.B.S. Exchange.

A brief description of the procedure adopted may prove of interest.

## Subscribers' Lines.

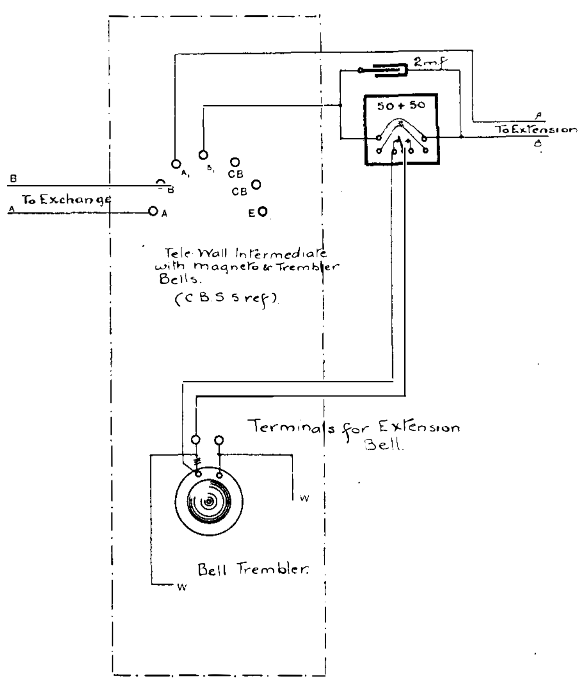
The lines were transferred to the new Exchange, by drawing in lead covered cables, and making teed connections at points most suitable along the various routes. Wherever heat coils B (28·5$^{\omega}$ to

31·5$^{\omega}$) were in existence in the line circuit, they were replaced by heat coils A green (5·5$^{\omega}$ to 6·5$^{\omega}$.)

## Subscribers' Apparatus.

(1) *Simple exchange circuits*, with or without simple extensions, *i. e.* without inter-communication facilities, did not require to be modified. At the new C.B. Exchange temporary alterations, which will be referred to later, were made which permitted either C.B.S. or C.B. instruments to be used at the subscribers' offices.

(2) *Exchange Circuits with one extension having inter-communication*

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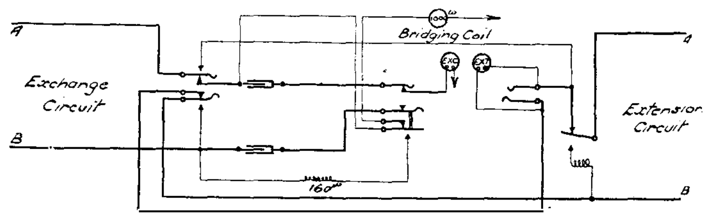
*facilities.*—Where C.B.S. intermediate instruments (Diagram C.B.S. 5) were in use, the connections of the local bell circuit were modified, as shown in Diagram **1**. This alteration was made to avoid a permanent ring on the trembler bell, when the extension was put through to the C.B. Exchange.

Where switchboards wired to Diagram C.B. **21**, were fitted, alterations were made to permit working either on a C.B.S. or C.B. Exchange, as shown in Diagram **2**.

Where wall-boards wired to Diagram C.B.S. 8 were in use, the 1000$^{\omega}$ bridging coil, associated with the exchange circuit, was replaced by a coil retardation $80_\omega + 80_\omega$, with the windings in series, so as to reduce the resistance of the circuit for C.B. working.

It should perhaps be mentioned that in order to avoid complaints of "faint hearing" during the period the C.B.S. instruments would

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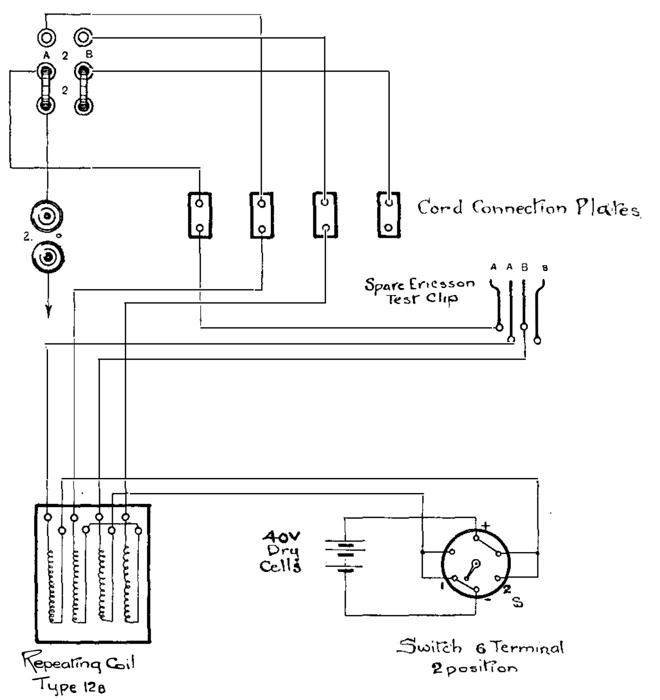
be connected to the C.B. Exchange, a speaking test was made from each subscriber's instrument to the Test Room, so as to ascertain that the subscribers' receivers were connected up in such a way that

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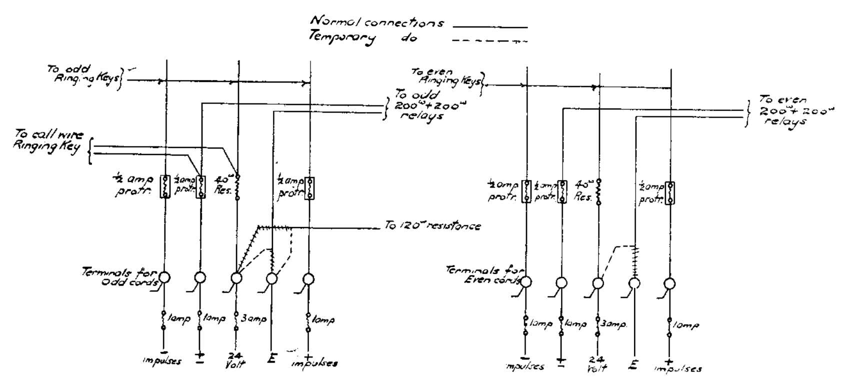
a positive current from the Exchange along the A wire would augment the permanent magnetic field of the receiver. The method adopted for conducting this test is shown in Diagram 3. A positive current is sent out on the A line, when the switch, S, is in position 1, and on the B line in position 2. The 40-volt battery at the Exchange, together with the introduction of 1000$^{\omega}$ bridging coils in the speaking circuit, enabled the lineman at the instrument to determine without difficulty in which position of switch, S, the hearing was improved, and if this condition was obtained with the switch in position 1, no change was made, but if better reception resulted when the switch was in position 2, the connections on the receiver were reversed.

## C.B. Exchange Equipment.

*Line Relays.*—As previously stated the C.B.S. instruments on simple exchange lines were not modified, *i. e.* the A line remained to earth *via* the 100$^{\omega}$ bell, and the other apparatus, which was modified, gave a similar condition. It will be obvious, therefore, that with the normal condition of C.B. Exchange working in London, *i. e.* with the 4-volt tap connected to the line relays, permanent glows




4

would be obtained. To obviate this, the line relays were served from the earthed positive pole of the 24-volt battery instead of the 4-volt tap; this alteration was readily made by transferring the main 4-volt lead going to the fuse-board, from the centre terminal (4-volt) of the discharge switch on the power board, to the centre earth-terminal of the discharge switch.

## Incoming Junction Circuits.

The wiring of the 4-party line ringing keys, provided in the new Exchange, required to be modified, as, with the subscriber's bell between A line and earth on the C.B.S. apparatus, the tripping relay 200$^{\omega}$ + 200$^{\omega}$ could not be retained in the generator lead; it was, therefore, placed in the ringing return lead, so that the tripping relay would not operate until the subscriber's receiver was removed. As there were no party-line subscribers at Richmond at the time of the transfer the desired conditions did not involve much rewiring. The commoned earth connection on the inner winding of the relay was reversed with the battery connection on the $120^{\omega}$ resistance spool. This alteration was readily made, as will be seen from Diagram 4. In addition, the machine ringing leads going to the fuse board were disconnected from the centre terminals of the ringing interrupter switch on the power board, and the disconnected positive impulse lead was then connected to the centre alternations terminal. The junction (B) operators were instructed to use "party 4" ringing key for "loop alternating" currents.

In order that the transfer could be carried out promptly, glass separators were placed between the springs of the cut-off relays, so that the battery and calling equipment would be cut off; this enabled the heat coils to be inserted on the C.B. main distribution frame, at any time suitable before the change over. The C.B.S. test frame was of the Ericsson type, which arranges for earthing, as well as disconnecting when the heat coils are extracted; the necessity for dismantling the earth strips prior to the transfer will, therefore, be apparent.

The only other preparatory work necessary for the transfer was the threading of tapes behind the heat coils on the C.B.S. test frame, so that at the time appointed banks of heat coils could be extracted quickly in an easy manner. As the heat coils were withdrawn, the cut-off relays were operated by plugging into the jacks on the new switchboard, so as to release the glass separators, but these operations did not occupy much time. The efforts of the operators to gain the attention of the subscribers were more fruitful than was anticipated, but this was doubtless due to the fact that Richmond is largely a residential district. To obviate any difficulty in transferring the junctions working to other exchanges, the precaution was taken to prove these lines through from the new switchboard, prior to the date of the transfer, and in addition a portion of the circuits to several exchanges were actually transferred an hour in advance of the subscribers' lines.

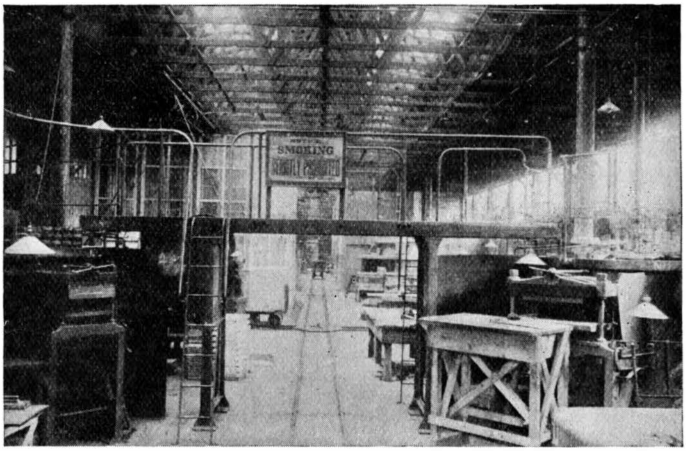
The number of lines changed over was as follows: Subscribers, 849; incoming call wires and junctions, 49; outgoing call-wires and junctions, 66.

# CHLORIDE ACCUMULATORS.

By H. E. Martin.

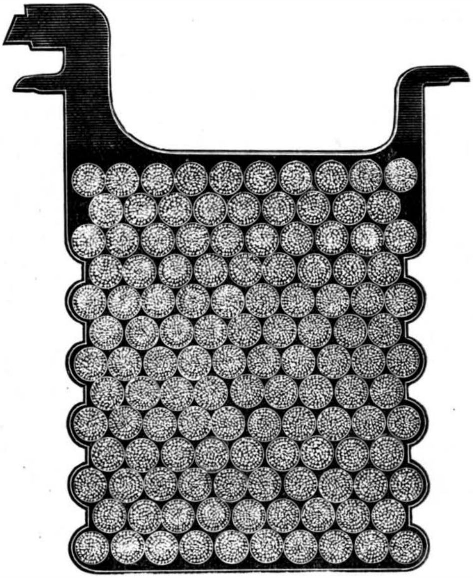
In response to an invitation from the Chloride Electrical Storage Co., Ltd., the members of the N.W. Centre of the Institution recently paid a visit to the Company's works at Clifton Junction, near Manchester. Having in view the fact that other members of the Institution or subscribers to the Journal may not be in a position to avail themselves of the opportunity of inspecting the up-to-date works of the Chloride Co., it is thought that a little information regarding the manufacture of the "Chloride Accumulator" will prove of interest.

The "Chloride" positive (2) consists of a plate distinct from the



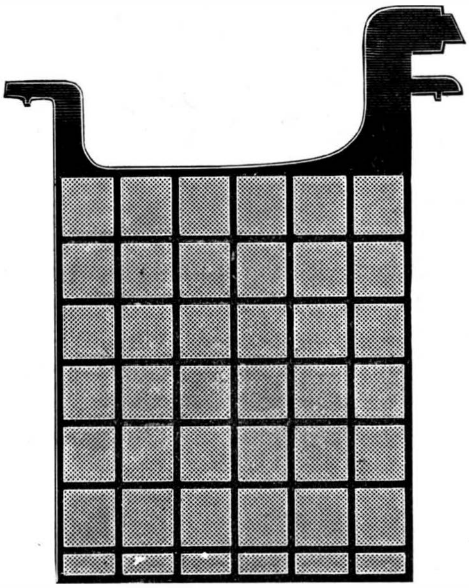

I.—The Casting Shop.

ordinary pure Planté plate, insomuch that it is built up, the active material being a different metal to the frame holding it. The frame is made of a lead-antimony alloy of great strength and stiffness, and rosettes of pure lead are inserted in a series of round holes in the frame. In the making of the rosettes lead tape is first drawn. A vertical press cylinder, fitted with a die having orifices of the desired section of lead tape, is filled with molten lead run direct from a furnace. When the lead is almost cold, the cylinder is driven against an overhead hydraulic ram, which, entering the vertical cylinder, forces the lead through the die, the result being two continuous ribbons of lead $\frac{3}{8}$ in. to $\frac{7}{16}$ in. wide, which are wound on to two wooden drums standing one on each side of the press. The working pressure is 4000 lb. to the square inch, and the weight of lead tape drawn at each operation is 448 lbs., *i. e.* 224 lbs. on each drum. The drums are then conveyed to the rosette-forming machines, which, while of a simple character, are very effective, and this remark might be applied to all the machinery observed in the works. The tape is fed into the machine and undergoes three processes — gimping, dividing into lengths, and rolling up into rosettes. The object of the gimping is to give increased active surface. The rolling of the tape is effected by passing it between a milled wheel and spring-controlled rack. The latest type of machine can deliver as many as 4000 rosettes per hour. The buttons are then placed on filling templates. The grids are placed over them, the template is pushed into a stamping-press, and then, under a pressure of 200 tons, the rosettes are all driven into position, standing out uniformly $\frac{1}{32}$ in. on each side of the



2.—Positive Plate.

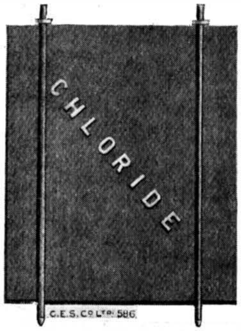
plate. During the subsequent "forming" process the slight expansion, combined with the fact that the holes in the grids are countersunk on each side, ensures the rosettes being firmly held in position. The process of manufacturing the frame of the positive plate consists in hot metal being run into moulds under an air-pressure of 150 lbs. to the square inch. The moulds are in two halves, mounted on presses in front of the lead furnaces. The castings are then passed through a punching machine, which clears all the holes in one operation, in readiness for the rosettes and the "gates," and any rough edges are trimmed off with suitable tools. The employment of lead-antimony alloy, in addition to giving the plate great mechanical strength, has the all-important advantage that, being inoxidisable, it is not affected by the chemical changes which take place during the life of a plate, and consequently the conductivity of the plates is never diminished. The negative plate (3) is known as the "box" type, because it is composed of two sections rivetted together after the insertion of the active material, which is then contained in a series of small cages or boxes. In the manufacture of this type of plate, perforated sheet-lead is cut into requisite sizes and cast on to skeleton frames. In the "mixing" department the paste for the negatives is prepared in rumbling machines, which consist of cylindrical chambers fitted with revolving blades. The paste is carefully weighed out and applied to the frames, which are then rivetted



3.—Negative Plate.

together under a special press. The grouping of the positive and negative sets is carried out in another department. The plates are evenly spaced in racks, and assembled on special casting tables fitted with moulding clamps. In these, at one operation, the strap-connector and plates are united to the section bars. There are numerous other interesting sections, such as the power house, the testing shop, carpenters' and mechanics' shops, the plumbers' shop, where the process of lining wood boxes with lead and building up the metal tanks for large telephone batteries is carried out, the reducing and forming departments, and, by no means least important, the chemical laboratory, where all raw material is tested prior to being issued to the works, and samples of electrolyte and water for use in battery installations are analysed.

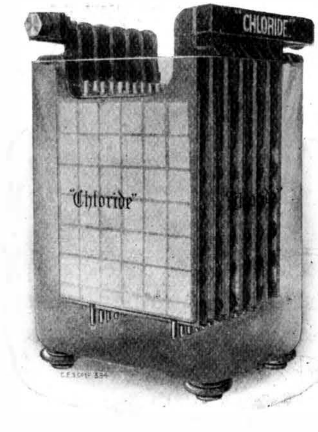
A distinctive feature of the "chloride" cell is the wood separator (4). These separators are cut to the exact size of the plates for which they are intended, and are held in position by means of wooden dowels, which are suspended from the top edges of the plates. The wood is subjected to a special treatment before being brought into use, which removes from it all substances which would in any way be harmful to the plates. It is claimed for the separators




4.—WOOD SEPARATOR.

that they tend to maintain the capacity of the plates in a manner which cannot be effected with the ordinary glass or ebonite separator.

Splendid accommodation is provided for the staff. In an industry where practically nothing but lead is handled, the necessity for cleanliness is obvious, and this fact is fully recognised by the Chloride Co.,




5.—ASSEMBLED CELL.

who take every possible precaution to prevent lead-poisoning. With the exception of glass-ware, everything required for accumulators is manufactured at Clifton Junction.

In conclusion it is desired to state that the greatest courtesy was extended by the representatives of the Company, and the pains taken to make all explanations clear were greatly appreciated by the visiting members.

# THE POST OFFICE RADIO-TELEGRAPH STATIONS AT TOBERMORY AND LOCHBOISDALE.

By A. C. BOOTH.

THESE two radio-telegraph stations were erected for the Post Office by the Marconi Company to supplement the single-wire submarine cable serving the Outer Hebrides *via* Stornoway.

Lochboisdale is situated on the east coast of the island of South Uist, while Tobermory is situated in the north of the island of Mull, where there is direct communication with Oban and Glasgow.

The distance between the two radio stations is sixty miles, almost entirely over sea, but the Tobermory station is, from a radio point of view, rather badly situated, being surrounded by hills. In spite of this disadvantage excellent working conditions prevail and strong signals have been received at both stations from the Marconi stations at Clifden and Poldhu, from the Eiffel Tower at Paris, and from the German station at Norddeich, near Emden.

The erection of the two stations was commenced in October, 1906, but was not completed until the following spring owing to delay caused by bad weather and two accidents with the mast at Lochboisdale.

The equipment of the stations is exactly similar and can be divided into three chief parts, viz. (*a*) the power plant, (*b*) the telegraph apparatus, and (*c*) the aërial structure.

The power plant consists of a 4 h.p. petroleum engine driving a 1½ kilowatt 4-pole converter at a speed of about 1600 revolutions. The armature of this machine has a commutator on one side and a pair of slip-rings on the other, providing either a direct current at 110 volts for charging the secondary cells or an alternating current at 76 volts for working through the spark-coils. When the engine is not in use the secondary cells are used to drive the converter as a motor and thus to supply the alternating current from the slip-rings.

The engine and converter, with the oil and water tanks, occupy a portion of a wooden shed, the other portion being partitioned off to house the secondary cells.

Lead-covered cables convey the current to the operating room, in which is fixed the controlling switchboard provided with the direct and alternating current ammeters, volt-meter, knife-switches, and fuses. The starting and field resistances are placed immediately beneath the switchboard.

To protect the armature coil of the converter from a possible burn-out due to sparking caused by high-frequency oscillations traversing the power leads, two straight filament lamps 150 volts 8 c.p., each in parallel with a condenser and a fuse, are joined, one across the leads from the commutator, and the other across the leads from the slip-rings.

The telegraph apparatus is placed in a smaller wooden hut adjacent to, but quite free from, the engine shed, so that no disturbance may be experienced, from the noise or vibration made by the running of the engine. The apparatus can be divided into two portions, viz. that used for transmission and that used for reception. In the former a Morse key is used to complete the circuit of the alternating current through a regulating inductance, and the primary coils of two 10-inch spark coils whose hammer-brakes are out of use, but are available in case the converter should for any reason be out of order. In that case a direct current would be taken from the battery.

As the alternating current is considerable the contacts of the Morse key are substantial, and in order to avoid the injurious effects of sparking, a vibrating key is joined across the Morse key; the tension of the spring of the vibrator being adjusted to break the circuit at the moment of reversal. In addition, a condenser in series with a resistance and fuse, is joined in parallel with the two keys.

The secondary coils of the 10-inch spark coils are joined in series and through two choke coils to the spark-gap, which is in parallel with a high-tension condenser joined in series with a tuning inductance and the primary of an oscillation transformer. The secondary of the oscillation transformer is joined on one side to the aërial wire and on the other to the earth lead, in which is placed a small spark-gap to insulate the aërial when reception is in progress.

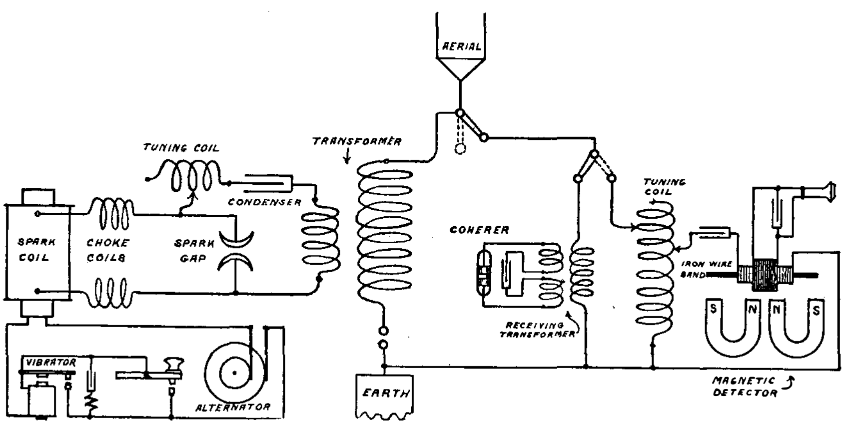
The action of the Morse key is therefore to send a low-tension alternating current through the spark-coils, whose secondaries provide a high-voltage current for charging the high-tension condenser through the inductance and oscillation transformer. When the condenser is sufficiently charged a spark passes at the spark-gap and the condenser is discharged causing an oscillatory current to circulate in the circuit made up of the primary of the transformer, the spark-gap and the inductance.

An oscillatory current is therefore produced in the secondary of the oscillation transformer and consequently in the aërial and across the spark-gap in the earth lead to the earth plates. This current causes electric waves to be radiated.

For receiving purposes the aërial is switched on to a transformer in connection with a filings coherer, which controls a sensitive relay working either a trembler bell for calling purposes or a self-starting Morse printer.

The coherer gives a speed of about twelve words per minute, and is too slow for ordinary traffic; but a much speedier arrangement limited only by the skill of the operators is also provided by the magnetic detector which enables the Morse signals to be read as sound signals from a double head-gear telephone. The detector consists of a slowly moving band of fine iron wires passing through a small coil of insulated copper wire. Around this coil is another and larger coil connected to the telephones, while the inner coil is connected through a condenser to the aërial inductance on one side and to earth on the other. These coils are situated in a strong magnetic field produced by two permanent magnets having their like poles adjacent as shown in the figure (1).

Electric waves in passing cause oscillatory currents in the aërial and its connection through the tuning inductance to earth. These oscillations set up other oscillations in the circuit made up of the

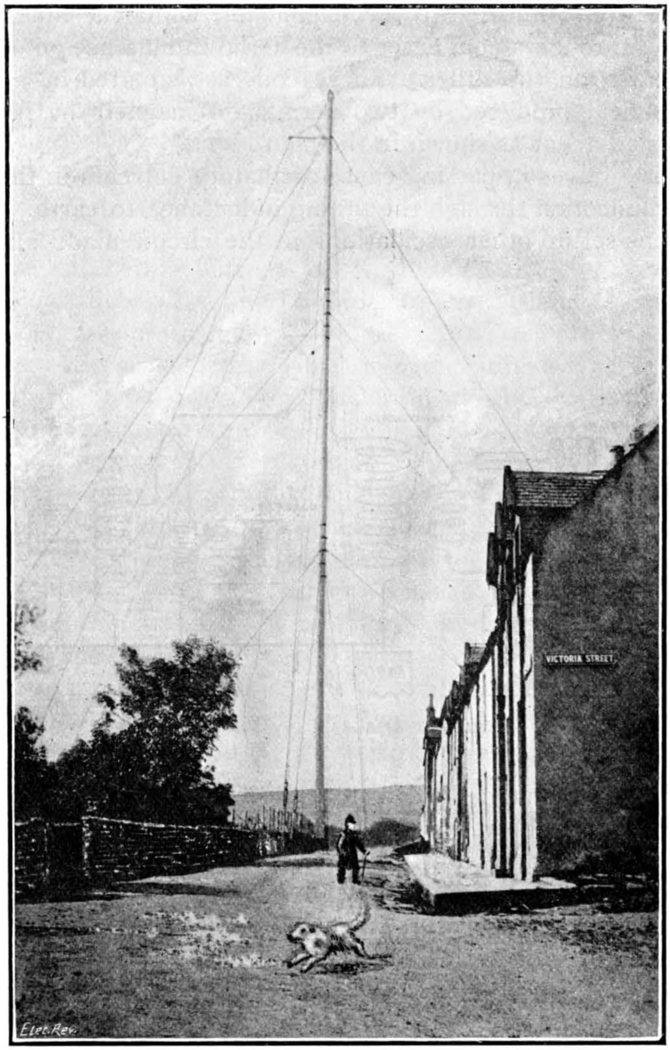



1.—Skeleton Diagram of Connections.

small coil of the magnetic detector, the condenser and the tuning inductance, with the result that the slowly changing magnetism of the moving iron band is disturbed, thus affecting the outer coil and producing a slight click in the telephones for each train of oscillations received. Hence Morse signals, which in this system consist of a number of wave-trains, are received as short and long musical notes.

The aërial equipment comprises the mast and its stays (2), the aërial wire proper, and the earth connection.

The mast is 150 feet in height, made up of three portions, spliced and clamped with four iron bands at the joints. The structure is supported by three sets of four stays of 2-inch, 2½-inch, and 3-inch steel and hemp hawsers, securely anchored through several turns of 2- and 3-inch rope lanyards and chains to ring bolts. The rope lanyards are to allow for adjusting the tension in the stays. The aërial wire consists of two lengths of 7/18 tinned copper separated by two wooden spreaders each 12 feet in length. At the upper end the aërial is insulated by a loop of rope passed through an india-rubber tube about 4 feet in length, while the lower insulator is an ebonite tube through which a brass connection-rod passes.




2.—View of Mast at Tobermory.

The "earth" consists of twelve sheet-iron plates each 5 feet by 2½ feet placed vertically in the ground around the operating hut.

A plug switch is provided for earthing the aërial direct during thunderstorms or when the stations are closed.

Signals from these stations have been received at the Post Office radio-telegraph stations at Hunstanton and Skegness, a distance of some 400 miles.

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## EFFECT OF WIRELESS TELEGRAPH TRANSMISSION ON A TELEPHONE SYSTEM.

The connection of a wireless station in the North of England to the local Telephone Exchange recently gave rise to a somewhat alarming experience.

The telephone circuit was provided in the first instance by an aërial line, two spans of which came within the staying ground of the wireless mast, which is 225′ in height. These wires were not adjacent to or parallel with any leads or wires of the Radio-Telegraph system.

The telephone wires were twisted in the usual way, and immediately outside the station grounds were associated with wires for other local subscribers.

When first installed the telephone circuit was provided with a battery at the station for signalling purposes, both wires being in use for this purpose, as well as for speaking. Under these conditions speech was rendered difficult during wireless transmission. The "spark" system was in use, absorbing some kilowatts of energy. Not only was speaking difficult from the station itself, but other circuits traversing the same routes were also seriously interfered with, the circuits being rendered noisy. False rings were received from time to time by the various subscribers, and sparking was also observed at the terminals of the Exchange indicators, causing some little alarm amongst the operators.

Arrangements were at once made to substitute cable for the aërial line on the station grounds.

Meanwhile, the change over of the local telephone system to common battery working greatly accentuated the difficulty, due no doubt to the fact that one of the wires was then normally joined to earth for signalling purposes. The disturbance under speaking conditions was not of course increased, but heat coils were now burnt out in considerable numbers at the station and Exchange, and the sparking became more evident. Lightning protectors were also affected.

As the suspension of an aërial cable in the neighbourhood of the wireless station did not improve matters a lead-covered cable was buried in the ground and terminated a few yards from the hut by means of unsheathed cable. This reduced the disturbance considerably, but did not entirely overcome it, and the lead-covered cable had to be extended into the hut and terminated close to the telephone instrument before the difficulty was entirely overcome.

At the station an "arc" system was also installed, but with these undamped oscillations no difficulty was experienced.

F. TREMAIN.

# ON THE PROPAGATION OF PLANE ELECTRO-MAGNETIC WAVES ALONG A PLANE-CONDUCTING SURFACE, AND ITS RELATION TO WIRELESS TELEGRAPHY.

By J. ZENNECK.

(Translated by H. HARTNELL, A.M.I.E.E.)

(*Continued from p.* 151.)

## 4. *Absorption of the Waves in the Direction of Propagation.*

(*a*) The absorption of the waves in the direction of propagation, *i.e.* in the positive direction of $x$, is determined by the value of $s$. If we put $s$ in the form

$$s = -(A - \iota B),$$

$\frac{1}{B}$ is the distance at which the amplitude of the wave is reduced to $\frac{1}{e}$th.

This distance in kilometres is given as a function of $\sigma$ for various values of $k$ in Fig. 7. The ordinates of the curve are proportional to the common logarithm of $\frac{1}{B}$.

(*b*) These curves show that this distance becomes a minimum for a certain finite value of $\sigma$. For smaller values of $\sigma$ the absorption is less. Since absorption, on the one hand, vanishes when the conductivity is infinitely great, and on the other hand when it is infinitely small, the existence of such a minimum is not surprising.

(*c*) The great influence of the dielectric constant of the conductor comes out very clearly; it has an importance at least equal to that of the conductivity. For $k = 80$

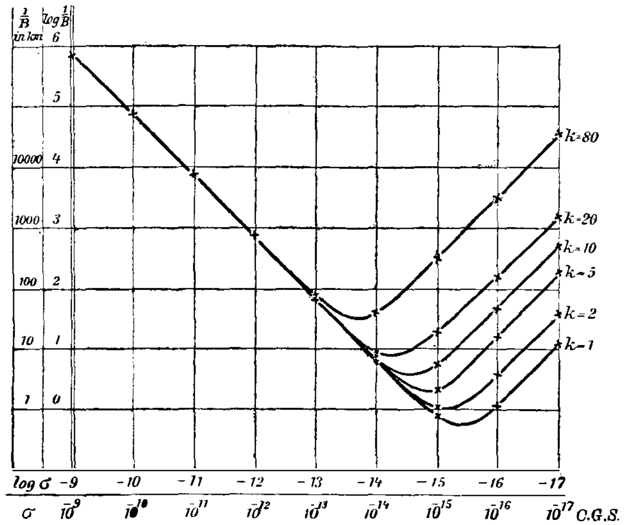
$$\frac{1}{B} = 400 \text{ kil.}$$

Whilst for $k = 2$

$$\frac{1}{B} = 1 \text{ kil.}$$

(*d*) So far as the effect of the frequency on absorption is concerned equations 7 give the following rule:

To obtain the length $\frac{1}{B}$ corresponding to a number of alternations

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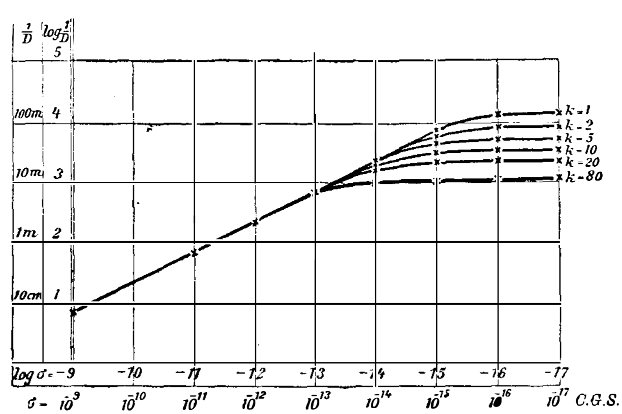
A .10⁶ it is only necessary to find from the curves of Fig. 7 the value corresponding to conductivity $\frac{\sigma}{A}$ and to divide it by A. For high

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conductivities the frequency, therefore, has great influence on the amount of absorption until the minimum value of $\frac{1}{B}$ (Fig. 7) is attained. For lower conductivities the influence of the frequency becomes less and less.

### 5. *Absorption of Waves by Penetration into the Conductor.*

The absorption of waves by penetration into the conductor is determined in a similar manner from the imaginary part of the co-efficient $r = C + \iota D$. In Fig. 8 is given the common logarithm of $\frac{1}{D}$ (cms.) for the depth at which the amplitude is reduced to $\frac{1}{e}$ of its value at the surface up to $10^{-13}$ C.G.S. the effect of the constant $k$ is inappreciable, as shown in Fig. 8. For lower conductivities it becomes more appreciable, but never attains the same importance as in the cases already dealt with.

On the other hand the absorption by penetration into the conductor is very great, as may be seen from the figure, if we remember that it is now a question of centimetres instead of kilometres, as in the case of propagation along the surface.

### 6. *Relations between the Intensities of the Electric and Magnetic Fields and the Velocity of Propagation.*

(*a*) From equation (2) we have:

$$\frac{E_{0z}}{M_{0y}} = -s.\frac{v}{\nu\varepsilon_0}.$$

Considering the value of $s$ we see that the absolute value of the ratio $\frac{E_{0z}}{M_{0y}}$ is never far from the velocity of light, and that the phase angle between $E_z$ and $M_y$ always remains very small. In general considerations we may regard $E_{oz}$ and $M_{oy}$ as having the same phase.

(*b*) The velocity of propagation $c$ along the surface of the conductor is

$$c = \frac{v}{A}$$

(A being the real part of $s$).

This value may be slightly greater than the velocity of light, and this is doubtless due to the fact that the direction of the waves is oblique with respect to the surface.

(*To be continued.*)

# "HOWLERS, TECHNOLOGICAL."

By Examiner.

*Question:* What is known by the symbols "H" and "B" in electro-magnetics? State what effect the introduction of iron has on the lines of force in a solenoid traversed by a current.

*Answer:* Symbols H and B stand for hydrogen and battery. The hydrogen of the iron bar allows the current from the battery to pass more freely through the substance of the iron, and the iron bar is made a strong magnet.

*Answer:* The symbols H and B in electro-magnetics means that the magnet is built up or fixed in position like or somewhat like the letters H or B. The effect of iron coming in contact or introduced into the lines of force in a solenoid would be to disturb and tend to render valueless the lines of force.

The foregoing answers, however, were capped by two other candidates, one of whom said that "the symbols H and B have reference to the height and breadth of coils. The height of a coil is best kept in direct proportion to the breadth"; the other said: "Symbol H stands for $H_2$ $SO_4$, and B for ——."

*Question:* What precautions would you take to secure a good earth for a telegraph circuit in the absence of gas- or water-pipes? What objection is there to the use of internal gas-pipes as earth connections?

*Answer:* In order to ensure a good earth connection for a telegraph circuit, it is absolutely necessary to keep the earth wire from passing into or through a rock as there may be some portions of metal of a different kind than at other places; the result would be that there would be earth disturbances and repeated faults.

In the absence of water-pipes or gas-pipes the wire may have to be carried some distance to say a pit of clay where there is usually a kind of liquid. If the earth wire were connected to an internal gas-pipe as an earth connection there is a probability that there would be an explosion by the pipes becoming heated.

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# A TRAIN HELD BACK BY A SPIDER.

On June 4th the 7.10 a.m. train from Ballyhaise Junction to Belturbet on the G.N.R. (Ireland) was detained for 100 minutes owing to a fault in the electric train staff instrument. When the energetic representative of the Post Office arrived on the scene he found that a *spider* had got between the contact points and the key lever at Belturbet and so caused a disconnection. It is not on record how many unsuccessful efforts preceded his achievement, but the far-reaching result of his final success doubtless exceeded his anticipations. No such previous case is on record.

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# REVIEW.*

"THE HUGHES AND BAUDOT TELEGRAPHS," BY A. CROTCH, OF THE ENGINEERING DEPARTMENT OF THE POST OFFICE, is a small treatise dealing briefly with the main features of these highly successful printing telegraph systems.

The illustrations regarding the Hughes instrument and its parts are exceptionally good and are worthy of a fuller description than that provided. The brevity is in fact carried a little too far in places. For instance, on p. 12, in describing the movement of the printing axle click, it is stated that "it is stopped by the shoulder *v.* of the detent arm," whereas it is the portion of the printing axle to which the "click" is attached that is stopped.

On p. 13 the movement of the printing-cam is said to "gradually" raise the printing lever T. ; and again, the correcting-cam is said to "gradually" turn round. Both of these movements are, in fact, very rapid, occupying roughly about one sixtieth of a second.

In the first paragraph dealing with letters and figures on p. 15 the type wheel is stated to "always move unit distance or some multiple of it." This conveys the impression that the type wheel has a step by step movement, whereas it is practically continuous.

With the above exceptions the description is good and well ordered, giving ample information for anyone desiring to obtain a working knowledge of the principles of the instrument.

The method of working the instrument is then dealt with, the author giving a description of the various adjustments necessary in order that two instruments may be made to work with each other over a telegraph line.

Duplex Hughes on the Differential and Bridge systems are next described and a full diagram of the connections given. Brevity is again in evidence in the sentence regarding the arms of the Bridge duplex, but is not likely in this case to be misleading: "unequal ratios, however, are not used, and the values of these are 3000 ohms each."

Lastly, repeaters for Hughes simplex and duplex circuits are described and illustrated with diagrams of the very numerous connections. Both these and the photographic reproduction of the duplex board are somewhat out of date, certain changes having been made in minor details, but the principle remains the same.

Under the heading of the Baudot system several pages are devoted to the

* "The Hughes and Baudot Telegraphs," by A. Crotch. Size $7\frac{1}{4}$ in. × 5 in. × $\frac{3}{8}$ in. Price 1*s.* 6*d.* Published by Rentell & Co., 36 Maiden Lane, Strand, W.C.

Delaney multiplex, simple and duplex, with explanations of the adjustments necessary to secure the passage of the various currents through the proper portion of the receiving apparatus.

Then follows a theoretical consideration of the passage of the signals in the Baudot multiplex, with a description of the "cadence" which is the warning to the operator of the correct moment to form the key combination for the next letter he desires to send.

The alphabet is then given showing which keys are to be depressed for each letter with the resulting currents that are sent to line, and the portion of the combiner in the receiving instrument corresponding to each letter.

The author goes a little astray on p. 50, where he states "it would be useless to send a second series into the translator until it has printed the first and is ready for the next." This actually does occur, viz. that before a signal is printed another set of signals has already been received on the electro-magnets of the receiver.

Good descriptions with ample illustrations of the keyboard and receiver are given, but on p. 61 the "levier d'accrochage" is translated as "hanging lever" whereas it should be "holding" or "locking lever." The same remark applies on the next page in reference to the "locking pin."

In dealing with the function of the moderator no mention is made that it provides a means for altering the speed of the receiver to suit its distributor.

The distributor is next described with illustrations of a front and side view. In the latter it is unfortunate that six brushes are shown on the front plate where four only are used, and the brushes on the rear plate are shown revolving in the wrong direction. The letterpress, however, correctly describes the instrument.

A rather important statement needing qualification is that at the top of p. 78 regarding the rate of the receiver in relation to the distributor. There is no need for absolute accuracy in this respect. The speed of the receivers may vary to some extent so long as they make the same number of complete revolutions as the distributor.

Lastly, a full diagram of the wiring connections is given and a general consideration of a quadruple Baudot circuit. Like the description of the Hughes that of the Baudot might with advantage be considerably amplified; it is, however, a very concise description of a complex subject, and we have no hesitation in strongly recommending this treatise as a carefully compiled and well-written description of two very important printing telegraph systems. The first is in use in nearly every country of Europe and the other is being rapidly extended.

# NOTES AND COMMENTS.

## Telegraphs and Lightning.

The article which will be found on another page of this issue detailing some of the effects produced on a telephone system by the operation of a radio-telegraph installation in close proximity suggests for consideration a fruitful field of inquiry, and one which is now far more ripe for investigation and discussion than it has hitherto been. The vagaries of lightning and the difficulty of forecasting its precise effects are well known. Hand in hand, however, with the development of radio-telegraphy there has of recent years been an increasing need for quantitative measurement and scientific research on the effects of high-frequency and high-tension electrical discharges. The demand has already produced fruit, and ideas are gradually becoming much more exact in these matters as one branch of electrical and physical science becomes welded up to another to confirm or refute hypotheses and assumptions. Though science advances by slow degrees true science is very sure, for so soon as another real truth is added to our store of knowledge it generally becomes possible to confirm it from one or other of the correlated physical sciences, often from a number of sources.

Present-day knowledge of the laws governing electrical discharges and high-frequency effects, though yet meagre enough, is far in advance of the knowledge of twenty, or even ten, years ago. Firmly established theories, however, always die very hard, false though they may be, and orthodox explanations of the effects of lightning and lightning protectors on telegraph circuits are no exception to the rule. For instance, the commonly accepted statement that a simple spiral of wire introduced between a cable and land-line at the point of junction or between line and apparatus will "choke back the oscillations" is dying a very hard death, though on mature consideration it must be obvious that since the self-induction of such a spiral is the main factor which determines its choking properties, and since the self-induction of an open spiral of a few turns is quite small compared with, say, two or three spans of the land-line, its power to choke back oscillations generated by a thunderstorm, perhaps some miles away, must be small indeed compared with that of the intervening part of the line itself. That the spiral is often effective in preventing damage to the cable or apparatus is not denied, but exception should certainly be taken to the explanation of the way in which the result is produced. This is no mere quibble, because unless the method of operation is properly appreciated the natural result is that the remedy is inefficiently or improperly applied. The knowledge gained by familiarity with the varying power of different types of electric sparks and discharges to produce effective oscillations in radio-telegraphy appears to shed a different light on the method of operation, which is to be traced to the influence which the self-induction of the spiral exerts on the spark produced at the lightning protector invariably associated with the spiral. How and why the spark occurs is another story that need not be entered into here. Any considerable oscillations which occur will be set up locally as a result of the lightning protector discharge, and if this discharge spark is to have the proper characteristics of an oscillatory spark it must be traversed by extremely rapid oscillations. The self-induction of the associated spiral is quite sufficient to so far reduce the natural period of oscillation that the spark is practically "killed." In the light of familiarity with wireless telegraph effects it is therefore probable that the function of the spiral is to kill the spark at the protectors, not to "choke back the oscillations."

Less need be said in refutation of the idea that fuses introduced between overhead and underground work in place of protectors will serve in any way to protect from lightning effects, though the idea still appears to hold in some quarters. Possibly it has arisen from the fact that substitution of protectors by fuses, if it has occurred, has resulted in less frequent trouble. This may well be if, as appears probable, the protector itself is the thief which causes some of the very trouble it is expected to remove.

Lightning protectors of the standard type will often be found to be a source of trouble in proximity to radio-telegraph installations, as it is quite easy to render a telephone circuit unworkable during the operation of a radio installation in the proximity by simply adding a lightning protector, whereas without the protector no trace of interference existed. Fortunately for wireless telegraphy, whose field would be hampered if it interfered seriously with wire telegraphy or telephony, it is possible to so arrange and operate both systems side by side that not the slightest interference is produced.

## First International Congress of European Telegraph and Telephone Engineers at Budapest.

This is an age of conferences, and leading men of science and commerce everywhere recognise the value of periodical meetings for the purpose of promoting their common interests.

It is therefore somewhat remarkable at first sight that European telegraph and telephone engineers, whose business it is to provide and extend inter-communication throughout the world, and whose lines are necessarily extended to each other at numerous points, should not hitherto have arranged to meet in conference.

The desirability of such a course has long been recognised, but numerous difficulties—largely due to the vastness and complexity of the interests involved—required to be overcome before a conference could be arranged.

The French Administration long ago proposed such meetings, and the matter was subsequently taken up by the Hungarian Technical Staff, to whose untiring energy and enthusiasm we owe the conception of the first Conference at Budapest, which was held from September 21st to September 29th. Delegates were present from Great Britain, France, Germany, Bavaria, Austria, Italy, Belgium, Holland, Denmark, Sweden, Roumania, Bulgaria, Servia and Russia.

Great Britain was represented by Major W. A. J. O'Meara, C.M.G., Engineer-in-Chief to the Post Office and President of the Institution of Post Office Electrical Engineers, Mr. T. F. Purves, Staff Engineer (one of the editors of this JOURNAL), and Mr. J. G. Hill, 2nd-Class Engineer.

The titles of Papers given at the Conference are appended herewith:

(1) "Automatic *v.* Manual Telephone Exchanges," M. Karl Barth v. Wehrenalp (Austria).

(2) (*a*) "Types of Underground Cable Employed in France"; (*b*) "Method of Working Telephone Trunk Circuits in France"; (*c*) "The Various Types of Baudot Telegraph Installations," M. Bazille (France).

(3) "The Underground System of the British Isles," Major W. A. J. O'Meara.

(4) "Telegraph Intercommunication and Concentration Switchboards," and the "Application of Central Battery Working to Telegraph Switching," Mr. T. F. Purves.

(5) "Practical Aspects of Telephone Transmission," Mr J. G. Hill.

(6) "Impedance of Telephone Circuits," M. Giovanni di Pirro (Italy).

(7) "The Best Apparatus for Steady Currents," M. Salvatore Montinari (Italy).

(8) "Disturbances Caused on Telegraph Wires by Currents from Electric Railways: Means of Remedy," M. Enrico Mirabelli (Italy).

(9) "Current Constants of Telephone Circuits," M. Béla Gáti (Hungary).

The publication of the papers and the discussion upon them will be awaited with considerable interest.

This, the first conference of its kind, will doubtless be the forerunner of numerous other similar ones, and we welcome it heartily as an influence which will make for unification of method and efficiency of working, and last, but not least, will tend to strengthen the bonds of mutual respect and good fellowship among the technical representatives of the telegraph and telephone services throughout Europe.

## Station List Supplement.

In response to suggestions from several readers we have arranged to publish station lists, in which we hope to give the present "whereabouts" of all Post Office engineers. As far as possible the rank and seniority position of each officer will be indicated, but the lists are, of course, unofficial.

As it seems probable that readers will wish to keep them separate from the Journal we have had them printed as supplementary pages and with the lists on one side of the paper. They can therefore be preserved and arranged as their possessors may desire.

## Sir W. H. Preece, K.C.B., F.R.S.

We regret to again disappoint our readers in regard to the promised article by Sir W. H. Preece on "Pre-Post Office Telegraphs," but we feel assured that in the next issue the same will appear. Sir William notifies us that he is making such good progress towards recovery that he is confident that the MS will be ready. All will be glad to hear of his convalescence.

# STAFF CHANGES.

## BRITISH POST OFFICE. ENGINEERING DEPARTMENT.

### Promotions.

| Name. | Appointment. | Previous Service. |
|---|---|---|
| Wilson, H. | Staff Engr., 2nd Cl. | Tel., Newcastle-on-Tyne, 1882; Relay Clk., Eng. Dept., 1892; Engr., 2nd Cl., 1896; 1st Cl., 1902. |
| Machugh F. H. | Suptg. Engr. | 1871; Insp., 1878; Engr., 1st Cl., 1893; Asst. Suptg. Engr., 1902. |
| Probert, J. | Suptg. Engr. | E.T. Co., 1864; Asst. Supt. School of Telegraphy, 1872; Supt. of Elec. Ltg., 1889. |
| Tresize, J. M. G. | Asst. Suptg. Engr. | Engr., 1897; Staff Engr., 2nd Cl., 1902. |
| Crompton, C. | Asst. Suptg. Engr. | Tel., Liverpool, 1885; Jr Clk., Eng. Dept., 1886; Engr., 2nd Cl., 1894; 1st Cl., 1900; Staff Engr., 2nd Cl., 1907. |
| Lever, G. | Engr., 1st Cl. | 3rd Offr., "Monarch," 1891; 2nd Offr., 1892; Ch. Offr., "Alert," 1893; Engr., 2nd Cl., 1901. |

### Death.

| | | |
|---|---|---|
| Ward, J. | Prin. Clk. | Clk., 2nd Div., M.O.O., 1884; E.-in-C.O., 1882; Clk., 1st Cl., 1900; Prin. Clk., 1907. |

# FOREIGN AND COLONIAL NOTES.

(*Specially written for* THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.)

## AUSTRALIAN NOTES.

*New South Wales.*—The first installation of a common battery system is now being taken over in Sydney Central Exchange, and an extension is contemplated. Hitherto the Central Exchange has been a branching multiple made by the Western Electric Company. There are multiple boards of different types in various branch exchanges in the Sydney Network, and many branch exchanges with 100-line standard boards and special incoming junction line positions.

Since the introduction of the Measured Service Regulations on February 1st, 1907, the rate of increase of telephone subscribers has been double that for any corresponding previous period, and extensive additions to the plant are in contemplation.

The Sydney Network is blessed with a fairly extensive system of tunnels in the centre of the city. These tunnels are for the exclusive use of the Postmaster-General's Department, and furnish an almost unlimited avenue for telephone expansion in the central area. Stoneware conduits are being extended from these tunnels in every direction as occasion demands and as funds can be made available.

In the country districts of New South Wales there has been a rapid expansion of small exchange systems connecting with the country post offices and also great extension of telephone communication, utilising existing telegraph lines by superimposed methods.

*Victoria.*—The Central Exchange in Victoria possesses one of the oldest series break-jack single-wire multiples in existence. In only one of the branch exchanges is there a multiple switchboard, although two of the branch exchanges have recently been fitted with multiple B positions, to remove immediate congestion, although in those exchanges the A positions still remain as 100-line standard Boards.

An extensive scheme of reconstruction for the whole of the area has been prepared, and includes new buildings and new switchboards for the City, Windsor, Hawthorne, Canterbury, and Brunswick Exchanges, and alterations to the existing equipment at others.

An underground system is also being commenced, and will consist of tunnels in the centre of the city, with stoneware conduits radiating therefrom.

The country district expansion in Victoria is growing in the same ratio as in other States.

*Queensland.*—Brisbane: A common battery switchboard is about to be installed and the subscribers will gradually be transferred to this board from the present branching magneto multiple installed in 1897.

*South Australia.*—At both Adelaide and Port Adelaide common battery switchboards are being installed. In Adelaide an underground system of conduits has already been completed and cables are being laid in readiness for a transfer to the common battery system. The introduction of electric traction in this city, which is to take place at an early date, renders it imperative that this change should be completed at about the same time.

*Western Australia.*—An underground system is also being introduced into Perth, and the introduction of a common battery switchboard at both Perth and Fremantle is in contemplation.

*Tasmania.*—A common battery switchboard was brought into use in Hobart about a year ago, and one is now being arranged for in Launceston.

Generally speaking the telephone development in Australia is exhibiting the same characteristics as in other parts of the world.

# CORRESPONDENCE.

*To the Editors of* THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

## MULTIPLICITY OF INSTRUCTIONS

SIRS,—No one appears to have taken up the question raised by "Perplexed" in the April JOURNAL regarding the question of indexing the various instructions issued by the Department. This cannot be on account of the want of importance of the subject, as many officers must be equally perplexed with your correspondent when necessity arises for finding any particular instruction, which may be only hazily remembered. As I placed informally before the authorities a suggestion which has not yet borne fruit, will you allow me to indicate the lines on which an "infallible" index might be framed. It is based on the Dewey system of classification adopted in great libraries. To meet our requirements each circular issued would deal with one subject only, and would bear in the top right-hand corner in bold print a number and date thus: $\frac{2\cdot132}{\text{Nov. 07}}$.

The number to the left of the decimal point would not exceed nine and would indicate the group or subject to which the circular referred. These subjects would be very wide ones, but should cover the whole of the business of the Department. The decimals would indicate the subdivisions of these subjects.

Suppose the subjects were somewhat as follows:

1·000 Wayleaves,
2·000 Estimates,
3·000 Construction and Apparatus,
4·000 Sub-heads,
5·000 etc. up to 9,

it follows that the circulars could be sorted into nine groups.

To sub-divide a group let us consider No. 3:

*Construction and Apparatus,* 3·000.

3·1 Indoor work,
3·2 Outdoor work,
3·21 Covered,
3·22 Open,
3·221 Pole-lines on roads,
3·222 ,, on canals,
3·223 ,, on railways.

In similar fashion, by using the decimal places, all the main groups could be split up and the *papers* could be arranged in numerical and chronological order by a boy copyist. Engineers would be furnished with a "key" drawn up as indicated, and when seeking instructions regarding the construction of, say, pole-lines on roads, would call for group 3·221. In fact the method, taken backwards, is on the lines of the "House that Jack built," for suppose it were required to trace mentally the group to which the glaze on an insulator belonged it would be—

The glaze on the insulator,
which is on the spindle,
which is on the arm,
which is on the pole,
which is on the road, canal, railway,
which is open work,
which is out-door work,
which leads to Group 3 according to the key.

It should be added finally that a master set prepared at headquarters and circulated would enable every office to be brought into line, and I venture to think this would be a great boon to engineers who belong to the migratory genus.

Yours faithfully,
H. P. STEED.

*To the Editors of* THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

## MULTIPLICITY OF INSTRUCTIONS.

ONE welcomes the introduction of the above subject in the April issue of the JOURNAL. Without doubt, it is a matter that lies at the very root of office organisation, and an interchange of opinions on the part of your correspondents cannot fail to be helpful.

Any efficient method of dealing with a mass of varied records must be a simple one, and in a Department like ours it is very desirable that all offices should have their records kept in the same way, so that an engineer going from one section to another would not be at a relative disadvantage by reason of the change.

The writer thinks that the adoption of the following system would put the matter on a perfectly satisfactory footing :

(*a*) All instructions to date should be divided into clearly defined groups, and be replaced by Standard Instruction Books covering all the points. (For convenience, in certain cases, the book might be printed in sections.)

(*b*) Each Instruction Book should have a distinctive coloured cover, and in cases where sections are printed separately all of them should be of the same colour, but distinctively marked in some other way (say with a large number).

(*c*) The Instruction Books should be thoroughly indexed before issue by the engineer, or other officer responsible for their compilation, for he alone will be in a position to bring out in the index the salient points. Poor indexing may reduce the value of the work immeasurably

(*d*) The Monthly List should then become a medium for distributing only addenda to the Standard Instruction Books. These addenda should be pasted into the Instruction Books only when they modify an existing instruction. New instructions should be kept in the standard file of the Monthly List until dealt with under (*j*).

(*e*) Every office should be supplied with a small card index cabinet of say six drawers, all the drawers being empty. A small supply of blank white cards and alphabetical spacing cards should accompany the cabinet.

(*f*) Each issue of the Monthly List should be accompanied by a batch of printed index cards for insertion in the cabinet. These cards should cover the instructions in the current issue.

(*g*) As the circulars in the Monthly List will each be an addendum of some Standard Instruction Book, each printed index card should be coloured—and marked if necessary, *vide* (*b*)—to agree with the cover of book concerned.

(*h*) All cards of the same colour should be kept separate in the cabinet from cards of other colours.

(*i*) In course of time the cabinet will begin to appear as though it is nearing the limit of its capacity, and this will be evidence that one or more of the Standard Instruction Books requires revision and reprinting.

(*j*) The reprinting of the book having been carried out, it should be issued with instructions to destroy all cards in the cabinets of that particular colour, together with such early numbers of the Monthly List as may no longer be required.

(*k*) The white cards issued with the cabinet are for use in indexing local records and general correspondence.

By this means would be ensured automatically—(1) a uniform system of indexing instructions; (2) the revision of Standard Books of Instructions; (3) the death, after a reasonable period, of the filed copies of the Monthly List; (4) the destruction, when not required, of the portions of the index covered by a reprinted book.

It will be interesting to have from sectional engineers and others any criticisms on the system suggested above.—Yours faithfully, B. O. ANSON.

*To the Editors of* THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

## EXAMINATIONS.

IN your editorial notes and comments in the last number you welcome the arrival of the Selection Committee who are examining second-class engineers for first-class engineerships.

Second-class engineers under the old *régime* had not to pass such an examination when their turn for promotion to first-class engineerships arrived.

We were selected in the main from the class of telegraphists for special qualifications in the way of certificates in scientific and technological subjects, and we obtained our sub-engineerships and engineerships after passing the recognised departmental examinations.

We had every reason to believe that we should obtain first-class engineerships—as in the past—by seniority and special fitness as shown by past work.

We cannot say by what system the second-class engineer in France proceeds to the higher appointments, but we do know that officers in the postal administration must be under thirty years of age if they wish to enter the École Professionelle preparatory to becoming second-class engineers. Many of us are over that age already.

The following extracts are worth comparing :

NOTES AND COMMENTS.

"They do these things better in France."

We hope the account of the French system will turn attention in this country to the possibility of founding a State school to train telegraph and telephone engineers for the Empire; a school in which students recruited from the staff and from outside could obtain a thorough theoretical and practical training. ('THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL,' July, 1908.)

ACROSS THE CHANNEL.

"They do these things better in France" was a favourite saying of our forefathers. In those days there were a good many things that they did better in France: in these days perhaps there are still some—but telephony is certainly not one of them. ('National Telephone Journal,' July, 1908.)

THE TELEPHONE SERVICE IN FRANCE.

A complete reform was necessary . . . in the selection and training of the staff in the general business administration of the Department and in its financial management. ('The Electrician,' July 10th, 1908.)

THE ARMY.

The examination system which the Chinese are giving up after trying it for more than five thousand years has come to our army with absurd intensity. The outlook of a young officer is a series of examinations. It is not because our officers are deficient in mental ability and vigour that they dislike these ordeals. Indeed, many of them are fond of study, and pass examinations for promotion as well as in languages with great credit. They do not like, however, to have examinations held over their heads like a whip, and made to cause uncertainty and anxiety. ('Chambers' Journal,' July, 1908.)

RUSSIA.

A recent visitor from Russia was asked why the telegraph and telephone systems in that country were in a backward state, and his reply was to the effect that the staff thought too much about examinations and too little about their practical work.

JAPAN.

A Japanese visitor recently intimated that the examination system was unknown in Japan—"They had no time for it," was his comment.

OUR COMMENTS.

We do not for one moment say that examinations are not necessary, but we urge that to enforce them at each and every stage of an officer's career is unnecessary, and detrimental to the real well-being of the Service.

The results of the tried British system may be judged by the large number of visitors we receive to study our methods.

In the outer world men rise without examinations—even Cabinet Ministers. The test of their ability does not depend upon an examination. It is based on past work.

SECOND-CLASS ENGINEER.

# STUDENTS' SECTION.

In this section, so far as space allows, answers will be given to any questions of general interest from an educational point of view. Queries should be addressed to Mr. A. W. Martin, Engineer-in-Chief's Office, G.P.O. West, E.C.

## CITY AND GUILDS OF LONDON INSTITUTE EXAMINATIONS, 1908.

### HONOURS TELEPHONY.

Question 4.—Give the names of the units and show the symbols generally employed to represent (*a*) capacity, (*b*) inductance, (*c*) electromotive force, (*d*) magnetic flux.

What is "reactance"?

*Answer.*—(*a*) Capacity is usually denoted by the letter K, but sometimes by C. The unit is the *farad*.

(*b*) Inductance is usually denoted by the letter L. The unit is the *henry*.

(*c*) Electromotive force is usually denoted by the letter E, but sometimes by V. The unit is the *volt*.

(*d*) Magnetic flux is generally denoted by the letter N. The unit is the *maxwell*.

(*b*) The effect of inductance in an alternate current circuit is to impede the rise and fall of the current strength. It is possible to show that—

If $C$ be the effective current strength in ampères,

$E$ ,, impressed E.M.F. in volts,

$L$ ,, inductance in henrys,

$R$ ,, ohmic resistance,

$p$ ,, $2\pi$ times the frequency,

$$C = \frac{E}{\sqrt{R^2 + p^2L^2}}$$

The quantity $\sqrt{R^2 + p^2L^2}$ is called the impedance, and $pL$, which virtually acts as spurious resistance, is called the *reactance*.

The effect of capacity in a circuit is reverse to that of inductance. If an alternate current circuit contain resistance and capacity without inductance the *reactance* is $-\frac{1}{pK}$ where $K$ is the capacity in farads.

If both inductance and capacity be present in a circuit the total reactance is the algebraic sum of that due to $L$ and $K$ respectively, or $pL - \frac{1}{pK}$.

Reactance may be said to be that part of the impedance in an alternate current circuit which produces the same effect as resistance on the strength of the current, and which causes a difference in phase between the impressed electromotive force and the effective current.

### ORDINARY TELEGRAPHY.

Question 2.—(*a*) How many cells of 2 volts electromotive force and negligible resistance would be required to send a current of 30 milliampères through an external resistance of 2450 ohms?

(*b*) Show why it is that a larger number of circuits can be worked on the universal system from secondary than from primary batteries having the same total electromotive force.

*Answer.*—(*a*) The general rule is that if—

$e$ be the E.M.F. of each cell in volts,

$r$ ,, resistance of each cell in ohms,

$R$ ,, external resistance in ohms,

$C$ be the current strength in ampères,
$n$ ,, number of cells required,

$$C = \frac{ne}{R + nr}.$$

$r$ in this case = 0, so that—

$$C = \frac{ne}{R},$$

$$\text{and } n = \frac{CR}{e},$$

$$n = \frac{0.030 \times 2450}{2} = 36.75$$

or 37 cells.

(*b*) An important difference between secondary and primary cells is that the former have no (or negligible) internal resistance while every form of the latter offers an appreciable amount.

When a steady current flows through any conductor, whether it be a battery or a wire, a fall of potential occurs therein which is equal to the product of current strength in ampères and the resistance of the conductor in ohms. In any complete circuit if $E$ and $r$ be respectively the E.M.F. and resistance of the battery and $R$ the resistance of the external circuit, the current $C$ will be found from—

$$C = \frac{E}{R + r},$$

$$\text{or } E = CR + Cr.$$

The latter expression means that of the total E.M.F. a portion, $Cr$, is utilised in urging the current through the resistance of the battery, and the remainder, $CR$, is available for sending the current through the external circuit.

It should be clear that if the internal resistance of the battery is negligible, as is the case with secondary cells, there can be no fall of potential in the battery, and the whole E.M.F. of the latter is available for urging current through any external resistance, and this no matter how strong the total current may be; but with primary cells the greater the strength of the current flowing through the battery the greater will be the proportion of the total difference of potential absorbed in the cells, and consequently that remaining for external use will diminish.

The current flowing through each of a number of circuits joined in parallel depends only upon the difference of potential between the ends of the battery to which they are joined *after all the circuits have been completed*. As no fall of potential takes place in a secondary battery, the difference of potential between its ends is constant and the current in a circuit joined to it is of the same strength, whether that circuit alone is completed or whether it be one of a large number. With primary cells the more circuits there are joined to the battery the greater becomes the fall of potential in it owing to its internal resistance, the less, therefore, will be the available potential difference between the extremities of the battery for external work. In this case the current in a particular circuit will not be the same when it alone is "joined up" as will be flowing when a number of others are connected in parallel.

# SOCIAL NOTES.

## SOUTH METROPOLITAN CENTRE.

### Kingston-on-Thames Telephone Exchange.

A launch trip, organised by the engineering and commercial staffs of the Kingston Telephone Exchange, took place on Saturday, June 13th. The large steam launch "La Burgoine" was chartered, and left Kingston for Egham at 3 p.m. with a party of 130 on board.

Mr. H. Hardie kindly provided gramophone selections during the afternoon, and after tea had been served an excellent musical programme was commenced. Mr. Bariscale, of the Gaiety Theatre, London, very kindly consented to assist, and his songs, viz. "Sincerity," "Gra McCree," and "Off to Philadelphia," were enthusiastically received. Miss E. Payne presided ably at the piano, and Miss B. Eldridge's performances on the violin were also much appreciated, Misses Armstrong, M. Cawthorn, E. Radcliffe, E. Dear, Thornton, E. Thompson, Messrs. Costello, F. McDermott, B. Wood, Hibbard, and Hill, contributed to the vocal portion of the programme, and the talent displayed was of a high order.

The Committee, which consisted of Miss M. Cawthorn, Messrs. H. Radcliffe, and A. Wakely, had evidently spared no effort to secure the success of the trip, and their aim was certainly achieved.

Mr. and Mrs. Harrison and family were present, as also were many officers of the Headquarters and local staffs of the Metropolitan (South) District.

It is proposed to arrange a second outing of a similar nature in August next.

### THE NATIONAL TELEPHONE BENEVOLENT SOCIETY.

The Entertainments Committee of this Society ask us to announce that they have arranged the following events for the coming winter: Four Lectures, four Whist Drives, Two Dances, a Social Evening, and a Smoking Concert. We have pleasure in doing so, and further particulars can be obtained from the Hon. Sec., Mr. F. C. French, Salisbury House, London Wall.

## CLUB NOTES.

### Lawn Tennis Match.—Engineering Department *v.* Stores Department.

This match was played under very favourable conditions on the ground of the Highgate Bohemians L.T.C. on June 29th, and resulted in a win for the Stores Department by 5 events to four. Most of the games were well contested and the result as far as sets and games were concerned was in favour of the Engineering Department, *i.e.* 12 sets to 10, 108 games to 105, so that the honours were very equally divided. Considerable difficulty was experienced by both sides in ascertaining the best available men, and it is hoped that at next year's meeting both departments will be represented by stronger teams. The scores were as follows:

H. W. Fulcher and E. H. Walters (Engineering Department) beat T. B. Barker and G. H. Macgregor, 6–4, 6–4; beat W. M. Cook and P. Green, 6–1, 6–1; beat H. E. Willmott and A. Burt, 8–6, 6–1.

A. H. Shepperd and A. E. Thorne (Engineering Department) lost to Barker and Macgregor, 3–6, 3–6; lost to Cook and Green, 6–2, 0–6, 4–6; lost to Willmott and Burt, 8–6, 2–6, 2–6.

J. E. T. S. Hilton and A. Warren (Engineering Department) lost to Barker and Macgregor, 9–7, 0–6, 7–9; beat Cook and Green, 6–3, 6–4; lost to Willmott and Burt, 6–3, 4–6, 4–6.

H. W. F.

## INSTITUTION NOTES.

Meetings of the Council were held at Bath on May 27th and 28th, 1908, and Matlock on July 22nd and 23rd, 1908, under the chairmanship of Mr. A. J. Stubbs.

The popularity of the Central Lending Library is well maintained, and the demand for books has been above the average for the season of the year. The stock of canvas pouches for the transmission of books has been found to be inadequate, and the Council have taken steps to obtain an additional supply.

It will be observed from this year's Annual Report that the accounts of the Institution have been subjected to a professional audit. In view of the growing importance of the Institution's work the Council have considered it desirable to substitute a professional audit in this and in future years.

The Council have arranged to reproduce the front covers of papers printed by the Institution, in order that members may have their sets bound into volumes, if they so desire.

The question of altering the constitution of the Council has been engaging the attention of the Council for several months. Schemes of representation, based on either a purely geographical or a purely class basis, have been discussed, but it has been unanimously agreed, after careful consideration, to continue the present constitution.

The membership of the Institution has increased from a total of 755 on March 31st, 1908, to 781 on July 20th, 1908.

A suggestion has been made that the services of University Professors, Lecturers, etc., should be requisitioned in order that lectures on subjects of special interest to members might be arranged at Local Centre meetings during the coming session. A committee of the Council has been appointed to ascertain whether anything can be done in this direction.

# OBITUARY.

## Mr. Joseph Ward, Engineer-in-Chief's Office.

*Died at Leytonstone, August 29th, 1908; aged 44.*

It is a trite saying of obituary writers that "Earth is the poorer" for the loss of the individual whose death they would incite us to mourn. But nobody who knew Joseph Ward will even dream of doubting its special applicability to his being and doing. Life was to him a school in which, as an apt pupil, he was daily learning *how to live*, and his death has set some of us wondering at the extent of our ignorance upon the problem. In him Life overcame Death. As we remember how he lived, we almost lack interest in the question of how he died. The last Enemy was really his best friend, in that it set him free from mortal pain, widened the scope of his vision, and enlarged his sphere of service. He could even afford to be humorous in the article of Death, for he was hopefully ready!

To write anything like an "official" tribute to a colleague whose inborn repugnance to red-tapeism seemed in its strength well-nigh comparable to his love of right and loyalty to duty, were a thankless task, and might even appear an affront to his memory. Within the wide range of His Majesty's Civil Service there was, it is no exaggeration to suggest, not to be found an officer with higher ideals of conduct. He was always Joseph Ward, a veritable genius in many of his conceptions, and, like unto not a few—let it be believed—of his surviving colleagues, devoted and true.

He had served in the Post Office for well-nigh a quarter of a century. Entering the Savings Bank Department in or about 1884, he was some two years later transferred to the office of the Engineer-in-Chief, and for a considerable period was attached to the Plan Section. Subsequently he was removed to the Estimates and Works Order Section, and there, under the writer's supervision, he speedily gained the unreserved confidence of his fellow-workers. Almost at once, thanks to his sterling qualities, he became the object of general respect, which with some of us quickly, and almost unconsciously as we found, had been merged in friendly regard, and ultimately had deepened into sincere affection. That a like process in the measure of appreciation, both of his gifts and graces, was also passing in the minds of his successive chiefs, we recognised evidence in their increasing trust and marks of approval, until, to the gratification of practically every brother officer, he was announced a Principal Clerk, in charge of the Staff Section. For that responsible position he soon convinced us all of his exceptional fitness, for it had been written of him upon the tablets of human hearts that "he loved his fellow-men." He was keenly discriminating in his judgment, tactful, uniformly kind and wise, while his love of goodness and truth amounted well-nigh to a passion. His unselfishness had passed into a proverb amongst us, and somehow it happened that every would-be critic of the "true and undefiled religion" defined in New Testament phrase was at once silenced by the living illustration of its power, furnished in their comrade, "Joe Ward."

We do not believe that God has destroyed the mould in which our colleague was made; nor can we for a moment give place to the idea that there is not still available an ample supply, for each and all of us, of the unseen might that had transformed him into so noble a soul, and of the beneficent love that sustained and directed its delightfully self-extinguishing exercise. So that it remains for us who are survivors to let our wreath upon his grave be a quietly serious resolve to impersonate his simplicity and faith, seeking to avoid even those inevitable mistakes and failures which the best of men do not always escape.

T. H. S.

## COMMUNICATIONS.

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