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ELECTRICAL NOTES OF A TRANSATLANTIC TRIP.

BY THOMAS D. LOCKWOOD.

Although the English *Electrical Review* has heretofore been so good as to intimate in speaking of some of my pen productions, that they are characterized by such a mixture of practical information and humor as only a true born American could produce, yet it is a fact, as some among you have long been aware, that I am of English parentage and birth, and lived in England for the first sixteen years of my life.

It thus came about that I was more easily enabled to assimilate in habit and thought with the English electricians whom I had the good fortune to meet, than is usual, and my visit, so far as the British Isles were concerned,—though the first one in twenty-four years—was much like the return of a wanderer to his home.

The most difficult part of this paper was the choice of a suitable designation therefor. I cogitated over many; among others, I thought for a moment of denominating it “A Visit to Europe and the Bull;” the Bull, of course, being playfully indicative of the domain of John of that ilk.

Calm contemplation, however, showed me that “Europa and the Bull” were out of question, and that such a title would have appeared in the highest degree anomalous to those who consider the United Kingdom as constituting a part of Europe. Moreover, it might be thought by others that as I spent so little time on the Continent of Europe and saw so little of it, I was not authorized to speak so grandiloquently of my humble few days in France and Belgium; and inasmuch as many of my observations,—for example those on outdoor electrical construction—are equally applicable to continental and insular Europe, there might be some doubt in the minds of my auditors whether there was any clean

cut line of differentiation between the two elements of such a combination title.

Indeed, while myself considering this composite caption, I was forcibly reminded of a remarkable passage in the life of the late Alfred Smee (he who was principally known as the inventor of the Smee battery, in which polarization was prevented or materially retarded, by making the negative plate of silver, coated with finely divided platinum), but who was really one of the most able of the early electricians and electro-metallurgists, and a general philosopher of high merit.

Mr. Smee, during the years 1845 to 1847, took a great interest in the potato disease, and his view that the disease was produced by the ravages of a variety of aphides excited considerable rancorous animosity and ridicule.

In a pantomime exhibited at Drury Lane, appeared the following:

Scene—A village with shows, etc.—little boy looking at a peep show.

Showman loquiter—"This is the aphid vastator as you may see, very much magnified by Mr. Smee." Boy—"Please, sir, which is the aphid and which is the tater?" Showman—"Which ever you like, my young investigator"

And in the same manner had I chosen the enterprising title already referred to, my hearers might have felt disposed to enquire: "Which is Europa and which is the Bull?"

My excursion, from the time I left home until the day of my return, extended over a period of twelve weeks, minus two days. I sailed from Montreal in the steamship "Vancouver" of the Dominion Line, and had a short passage and over 48 hours of river and gulf sailing.

Passengers taking this route have a very short sea space and a correspondingly long and delightful smooth water and land-locked experience; they have a greater chance of seeing icebergs, whales and porpoises, with a certainty of cooler weather and a reasonable possibility of rougher seas. I returned in the "City of Rome," the only Anchor Line steamer plying between Liverpool and New York.

I staid on my arrival in England a few days in Liverpool, passed on to the Derbyshire peak district, then to Birmingham. From thence I went to London, making my headquarters not in the city, but in a most beautiful town, Tunbridge Wells, which

is an inland watering place some thirty miles distant, in Kent. Later I passed over by way of Dieppe to Paris, and after a few days there, returned to England through Brussels and Antwerp.

After staying a few days more in London, I went to Scotland, calling at the Cathedral cities of Lincoln and York, and at the manufacturing city of Newcastle-on-Tyne. I halted at Edinburgh, passing on later to Inverness, via Perth; and then down the Caledonian canal to Glasgow, and back to London, stopping en route once more at Edinburgh. Then I took a side trip from London to Salisbury, Bath, Gloucester and Worcester, and again returned to London via Oxford. Finally I started from London to Chester, a most charmingly antiquated walled city, visited some of the North Wales watering places, inspected the mediæval castles of Conway and Carnarvon, climbed Snowdon, sailed from Holyhead to Dublin, took railway to Cork, passing the celebrated Blarney castle and stone, spent a day at Killarney, and took ship at Queenstown.

My visit was not a business trip, and I made no attempt to combine pleasure and business, but it is hardly necessary to say that I did not travel with my eyes shut; and that when anything electrical came before me, I had no hesitation in making observations on it. However, my observations were somewhat desultory, and my account of them will necessarily also partake of that character.

TELEGRAPHY.

I saw little of interest in telegraphy until my arrival in London, where I lost no time in looking up William H. Preece, the well-known electrician of the British telegraphs, whose urbanity and good nature were as usual far above par. By his favor I was able to inspect the central telegraph station, which is located in an immense building in St. Martins Le Grand, just opposite the general post-office building proper.

I was placed in the care of Mr. Cooper, a genial gentleman, charged to a high potential with useful information, and in his company paid my respects to H. C. Fischer, the controller of the central station.

Mr. Fischer, with whom I had had some previous acquaintance during his visit to America in 1877, made strenuous efforts to recollect me, and I think succeeded, although I am not sure. But if his recollection was not perfect, it was at least a good imitation, and did not in the least interfere with the cordial reception which I received at his hands.

The London operating room, or rooms, is an immense affair. Heretofore I had a most exalted opinion of the size of the Western Union room in New York, but the London room was a decided revelation. I noticed a very peculiar effect there. When first introduced, a good sized room filled with operators, or more properly telegraphists, and apparatus dawned upon my vision, and together with Mr. Cooper and the superintendent in charge, I wandered through it; but near the end we suddenly turn a corner, and another vista as wide and long as the first, appears, which again we traverse only to find once more as we approach its farthest limit, that a third vast expanse lies before us, and so on apparently for half a dozen successive times. Then I was led upstairs where a similar succession of rooms was exhibited to my bewildered gaze.

Morse instruments, both sounder and ink writer, were there to be found. The single needle also appeared to hold its own, and I saw something new to me, viz., telegraphists reading by sound from the click of the single needle as it vibrated from one side to the other, striking its limiting stop.

With respect to the Morse, I do not think the average transmission is as fast as is the American average, nor do I think it possible to achieve extremely rapid sending with the heavy keys generally in use.

I was greatly interested with the way in which the Delany multiplex has been taken up by the British telegraphic authorities. It may have been in some degree improved and modified, and I understood that the number of circuits simultaneously worked successfully, were not as great as had been hoped for, but still it was in use; its use was increasing, it was doing good work on lines of considerable length, and the operators liked it.

Upon making inquiries about the Wheatstone automatic, it was to be noted that while authorities united in enthusiastic praise of its qualifications as a fast telegraph in all cases where the matter transmitted was to be received in duplicate or in multiple, such as news, the praise was by no means so emphatic with respect to its ordinary use as a means of transmission for business messages, as so much time was required to be taken up in the preliminary measure of punching.

The Pneumatic Dispatch branch of the London station is on an equal scale of immensity, and in fact is one of the great features of London telegraphy. Throughout the length and breadth

of the land I found civility and prompt attention in the matter of receiving and delivering telegrams. Early and late I tested the telegraphic service, and found it up to the mark.

It is, I believe, a regulation that all telegrams are to be prepaid by stamp ; the said stamps in all cases to be affixed by the sender. The former of these provisions is no doubt invariably carried out, but as the latter is not always, I cannot speak positively as to either.

As a matter of fact I was rarely required to affix my own stamps in telegraph offices in large cities, whereas the letter of the law was fully carried out in small places, the principle being, I suppose, at these places, to make up in formality for what was lacking in amount of business.

The facilities for telegraphy in the United Kingdom are wonderfully complete, and I found no place too small for a telegraph office ; moreover in my opinion, telegraphy is there cheap, in spite of the fact that the address and signature has to be counted in and paid for.

The dynamo does not appear to be employed as a source of telegraphic currents, and here, I think the British telegraph system is a little behind the times. Yet, as far back as 1873, I understand that Mr. Preece experimented with the Gramme machine for this purpose, but found it too unsteady for the Wheatstone automatic instruments.

There are 2,300 cells of battery in use at the central station in London, and 220 circuits are supplied by accumulators.

Do I approve of the telegraphs being owned by the government ? In a monarchy, whether limited or absolute, yes. Because the government is permanent and usually stable. It answers well in England ; it is cheap and good. But does it pay ? Well, if you consider that the agencies of a government should be administered for the people's benefit, I think it does. But for a republic, at least one like ours, in which radical and sweeping changes of administration occur at frequent intervals, I am clearly of the impression that a government ownership would be an unqualified evil. No doubt a government control leads to a superabundance of red tape ; to the ridiculously excessive formalities of the "Circumlocution Office ;" and to extreme conservatism. It also acts as a damp sheet upon invention. Yet in spite of these tendencies, the telegraphs of the British Isles are, I think, on the whole, better managed and better manned, than

they would be by one or more corporations ; and the question of remunerativeness seems to me quite of a secondary character, since even though the telegraph department be not profitable, it seems at least evident that the people are enjoying a lower rate than they would under other circumstances be entitled to or receive.

The rigid use of discipline was, however, well illustrated in an attempt which I made to see the telegraph office at Birmingham, but where I was told that they would have to write to London for permission to allow my visit. I could not wait the exchange of correspondence and thus have not as yet seen the telegraph office there. It seems the telegraph department does not use its wires at all on office business, but employs the mail altogether, the wires being reserved exclusively for paid business.

ELECTRIC LIGHTING.

From my point of sight as an electrical engineer I was disappointed to find that electric street lighting was, comparatively speaking, still a thing of the future nearly all over the Kingdom. Not that electric lighting is not being done, but that so little of what can be done is seen. Instead of having electric illumination all around you as we have it, we have, so to speak, to hunt up installations.

There are a number of central station plants in London, but London is an immensity and might contain many more, and yet electric lighting would be conspicuous by its paucity. You may, for example, walk through Holborn and Oxford streets and see lines of glorious shops lighted electrically ; you may go to Grosvenor gallery and watch the historical illumination there ; and you may at various factories see that the electric light is for this class of work being extensively employed.

The Great Western Railway station at Paddington is lighted up by 100 arc lamps and an infinity of incandescent hairpins ; and many seaside resorts know of the electric light ; while at Glasgow and Liverpool are central lighting stations of high capacity, but in spite of all this, you cannot help forming and bringing home the impression that there has been but little done in this branch of electrical application. The truth is that the British public seems to have had a surfeit of electric lighting companies at an early date, with all that an electric lighting

company implied in the years 1878 to 1882, and has of late years had no wish to take a second dose.

As a telephone electrician, I felt disposed to congratulate the telephone and telegraph people that they had escaped the horrors of burned out central stations and disturbed circuits.

Such lighting companies as may hereafter undertake to occupy this field are also to be congratulated that they will have the several years' experience of others, and all of the many improvements which have been produced in apparatus and insulation to profit by. I think that municipalities in England will themselves shortly take up this matter. In no case, I am sure, will "undertakers' wire" or the reckless class of construction which we have too often seen in this land of liberty be tolerated.

Isolated house lighting, is however, well advanced. Inquiries which I made proved that this branch of incandescent electric lighting which has overflowed upon the steamships and boats is very popular. In the several examples of it which came under my personal notice, the electricity is drawn from secondary batteries, which are during the day charged by a dynamo.

I had the happiness of dining with W. H. Preece, at his house at Wimbledon, and of examining his lighting plant. He uses the secondary cells of the Electrical Power Storage Company. The plates are formed of a leaden grid, the perforations of the positive plate being filled originally with minium, while those of the negative plate are filled with litharge. The charging dynamo was run by a gas engine, and Mr. Preece informed me that it cost him exactly as much for gas as it did when he used gas for illuminating purposes, while he had a much greater amount of light. I am bound to state, that in my opinion, the light was superb, being apparently softer and more equable than when obtained directly from the dynamo.

While upon this subject I may state that I also had the pleasure of inspecting the beautiful laboratory and workshop of Sir David Salomons, at Broomhill, Tunbridge Wells. Sir David is a wealthy amateur who has made the realm of secondary batteries peculiarly his own, and who has written a textbook on their construction and care, which, if not absolutely faultless, is certainly the most useful and practical work on the subject in existence. He has a pair of fine compound steam engines and several dynamos, these being connected with the prime motors by leather link belts of American manufacture.

A great number of storage cells, several hundred I should judge, and in prime condition, are located in a side room, floored with glazed tile, the entire floor sloping to one side for purposes of drainage. In the machine shop I saw some of the finest machine tools that my eyes have ever fallen upon, lathes, drills, planers, shapers and so forth, and it was particularly noticeable that each machine was provided with its own electromotor. All of the motors were of the Elwell-Parker make. Upon a shelf in the laboratory office were a few well-chosen books, among which I noticed the last bound volume of the proceedings of this Institute.

Sir David uses these motors for every conceivable purpose, furnishing electric light and power for his entire establishment, and while I was there, electricity was employed in making butter. If an electrician, whose heart is in his work, is ever justified in cherishing envy in his bosom, it is when visiting such a place as that of Sir David Salomons, and he has my heartiest acknowledgments for the kind way in which he allowed me to inspect the same, though himself absent.

I saw throughout my travels little in the motor line, except those to which I have referred, but I am informed that the use of electromotors in Britain is already great, and is rapidly increasing.

TELEPHONY.

The chief centers of good work in telephony are Dundee, Glasgow, Liverpool, London, Edinburgh, Manchester and Birmingham. The fact that I mention Birmingham last, shows that no attempt at classification has been made. I could not inspect the Liverpool central station as I happened to be there only during holidays, when the authorities were all absent, and for lack of time I was unable to visit Manchester at all, but I saw a good deal of the Liverpool outside construction, and I heard enough about Manchester, to assure myself that the installation was par excellence.

Many of you will be aware that three of the principal telephone companies in England, viz., the United, the National and the Lancashire and Cheshire, have recently joined their forces under the name of the National Telephone Company, Limited.

This company has now taken charge of the London Exchange, where I was rather surprised to find that there were already more than 7,000 subscribers.

There, nearly all lines were built over the housetops, with tubular iron fixtures of a construction, beautiful and light and yet strong. A very peculiar feature of this London construction was that the wires of a route were, as a rule, all strung in a vertical plane, there being very few cross-arms. This made a very symmetrical appearance, but it struck me that it was hardly a sufficient utilization of a route, or, as the Britons say, of the "way leave." This, however, was the work of the United Company, and I think was not in accordance with the judgment of the engineer of that company, who remains in the same capacity with its successor.

The post office department charges the telephone companies a regular royalty, it having been legally decided that the telephone is a "telegraph" within the meaning of the statute. The postmaster-general apparently does not like the action of the companies in uniting, although none of them were competitive, but all working in distinct territories. There is no doubt, however, that he fears that the capitalization will unnecessarily enlarge and will be a big bite for the government mouth whenever, and if ever, purchase may be decided upon.

It does not seem to be likely that the postmaster-general will take any steps to harass the companies, nor do I believe that the post office telegraph department will care for a long time to come to trouble itself with telephony, and it is my opinion that the remaining telephone companies will soon in turn be absorbed or otherwise united with the National Company.

Long line telephone work in Great Britain is, of course, limited by the size of the island and by the peculiar relative position of the large towns. I found very good talking between Birmingham and the several towns of Sheffield, Derby and Nottingham; between Glasgow and Edinburgh and Dundee; and especially fine from Sunderland to points upward of a hundred miles distant. For these latter distances circuits had to be artificially made up. In London there are necessarily many central telephone stations. No one who has not seen and studied London can form an idea of its vastness, and by reason of this vastness there will always be (notwithstanding the manifest excellencies of centralization) a plurality of central stations connected by trunk lines, mainly converging to a principal trunk station, but supplemented by a sufficient number of trunks between such central stations as are adjacent to each other. Yet I should say that there are at present

too many central stations and that they are too close together, and I am under the impression that the present management thinks so, too, and will condense closely grouped central offices considerably.

In Scotland I found a regular multiple switch-board in the Glasgow central station, which was the most American looking central station which I have seen anywhere. In Glasgow, also, a "nickel in the slot" toll box has been devised, and is largely used at public stations, a penny or a certain number of pennies being the local charge, and a sixpence, or more, the trunk line or out of town charge. The operator can tell by peculiar sound signals automatically given by the passage of a coin or coins whether the proper amount is dropped in, and if not, the machine simply absorbs what has been put in and does not grant the desired accommodation. Regular subscribers have a check key which operates the apparatus without requiring the electro-deposition of a coin. This machine is well spoken of, and is said to give satisfaction. In some other parts of England these boxes are also used, and non-subscribers to the exchange may purchase a local check key for the purpose of using at any time the public station without having to pay every time. It may be of interest to state that at every railway station in England the "nickel in the slot," or rather the "copper in the slot" machine, applied to a variety of uses, is to be found. The weighing machine is the most popular, but the electrical shocking machine is a close second.

The best working long lines which I found were without doubt those belonging to the Northern District Telephone Company. This company is in charge of C. B. Clay, of Sunderland: the lines are new and are built of the latest model.

In Newcastle, all lines, both telegraph and telephone, which are owned by the government, are underground. They work very well, and the government telephone system there is ably managed by A. W. Heaviside, who based his telephone exchange upon a pro-telephone exchange, actually existing in Newcastle, and operating dial telegraphs long before the telephone exchange was thought of, or the telephone itself invented.

The National Telephone Company is fortunate in having such men as Messrs. Bennett, Coleman, Jackson, Phillips, Sinclair, and as far as possible employs men trained by previous education and experience to be equally efficient in a business and technical capacity.

As to electrical construction outside, I may say without hesitation, that the average is far above ours, whether telegraphic, telephonic or otherwise. The poles are no longer than are necessary, are uniformly well trimmed and painted, and above all are well stayed. Mile after mile I have ridden on a railway both in England and on the Continent and found every pole "stayed," or as we would say "guyed." The cross-arms are usually short, and project alternately a greater distance to one side or the other—that is, the upper cross arm may carry two insulators on the right side of the pole and but one on the left, while the next will reverse that, two being on the left and one on the right, and so on. The telephone companies had much housetop construction, but the same system of staying prevailed, so that the construction was superb, even though the roofs were all of the pitched variety. In Sunderland only, and the other towns where the Northern District Telephone Company holds sway, are to be found long cross-arms a la American, the idea having being imported by Mr. Clay, who visited the United States a year or two ago, and who is a manager of the most progressive type.

In Edinburgh, though nearly all wires were overhead, they were so symmetrically arranged as to be hardly noticed. A. R. Bennett, who is general manager of the Edinburgh district, looks also after Dundee, Galashiels, Dumfries and many other towns. The above remarks apply alike to the government construction in Great Britain, France and Belgium, and to the construction of telephone companies.

The only underground telephone line work which I found was the well known Paris sewer work and the government telephone exchange wires at Newcastle-upon-Tyne; but the National Telephone Company is beginning to lay some underground wires in Birmingham.

At Birmingham I also noticed some little pole work, and it was both amusing and instructive to see that, wherever possible, the poles were modestly planted close to the gable end of a block of buildings, or inside of a high fence, or in the corner of a vacant lot, so as to attract as little notice as possible.

I found that silicon bronze wire was well thought of throughout the several territories which I visited, and in general use. It can be made of a conductivity nearly as high as copper, while it is tougher; and it is much better for telephone work than iron, because not only is the conductivity higher but it possesses a much lower co-efficient of self-induction.

One telephone span I saw in the south of England crossing the opening of the Dartmouth harbor, which was certainly not much less than half a mile in length. I venture the prophecy that in the near future we shall use silicon bronze here in the United States much more than heretofore we have done.

In France I visited of course the Exposition, and met Messrs. Abdank-Abakanowicz and Berthon, both old friends. The finest electrical affair about the Exposition, to my mind, was the way in which the great fountain was illuminated in kaleidoscopic colors every night. This has, of course, often been done before, but never, I think, so perfectly or on such a scale. The success of the installation is due to Mr. Aylmer, who has had it in charge.

I stood in the tower and admired, and then I went down through the tunnels and stood beneath the fountain, where the arc lights were reflected through colored screens and through the plate glass floor, and marveled and admired still more, especially when I saw how the levers arranged in the tower like those of the Pennsylvania railway signal tower, worked pneumatically the screen mechanism below, and kept an ever-changing succession of beautiful colors upon the different fountain jets; and all this apparently, so far as the crowd could see, working itself; for there was no manifest link between the operating tower and the fountain.

The Exposition telephone station, as arranged by L. Berthon, was a sight in itself, with its multiple switch-board, its closets for private communication, its samples of fine electrical apparatus made by the Societe Generale des Telephones, and its apparatus and circuit arrangements for receiving operative performances and re-issuing them for the delectation of numerous auditors.

Long telephone lines stretch from Paris to Havre, Lille, Bruxelles, Lyons and Marseilles, and work admirably. These are chiefly of copper and are arranged in metallic circuits.

Mr. Berthon, the managing engineer of the Societe Generale des Telephones, told me that his company while sparing no effort to keep up its efficiency, had for some little time been resting on its oars in view of the possible purchase of its telephone property by the government. And, as you are aware the government has since decided to acquire this property, and has in fact taken possession of it, which action, I believe, to be an unfortunate one, alike for the government, the society and the people.

Of course the great Edison exhibit with its 9,000 feet of floor space was a tremendous affair; and, although it would naturally impress the observer without any extraneous aid, it is fair to say that its merits were literally hammered into the visitor's mind by the able enthusiast who had it in charge.

This, together with the surprisingly fine exhibit made by the Thomson-Houston company in association with the Thomson Electric Welding company, and also the unique historical exhibit, made by the American Bell Telephone company, fully redeemed the electrical section from any participancy in the otherwise too true charge that the share of America in the great exposition was comparatively insignificant.

The compound engines, built by Messrs. Davey, Paxman & Co., of Colchester, England, to run the dynamo for lighting the fountain tower, and exhibition, were an interesting sight to me. I was delighted to watch their fine and speedy regulation as the requirements varied. The young man who was running them, was a rising electrician, H. D. Wilkinson, the same who succeeded Mr. Kennelly in the authorship of the series of electrical measurement articles lately published by the London *Electrician*.

Mr. Wilkinson, believing it right to give himself a practical intimacy with all branches of electrical engineering, was taking this method of doing so, and illustrating the English tendency to carry out to the fullest extent the scriptural maxim "Whatsoever thy hand findeth to do, do it with thy might."

I was favored by Messrs. Siemens Bros. & Co., by permission to visit their works at Charlton, Woolwich. There I found active work going on in all branches of electrical manufacture, but the most new and interesting feature to me was the submarine cable work which I witnessed in various stages. This I could not avoid reflecting, is the one branch of electrical work in which Britain is practically without competition. Here I met Frank Jacob, the electrician of the Siemens company; a remarkably able and intelligent man, and the inventor of one of the earliest systems of multiple telephony and combined telephony and telegraphy. A most interesting feature of the Siemens works is the testing room, where every foot of cable is tested during the process of manufacture. Immediately across the river and thus an opposition physically as well as commercially, is the rival cable establishment of Silvertown.

Speaking of manufactories, brings to mind that the tendency

of the British business public to consolidations (or amalgamation as it is mercurially termed), after having swept over all the breweries, distilleries and gas companies within reach, and after having touched the telephone companies, is now exerting itself upon the electrical manufacturing interests, as evidenced by the fact that all of the storage battery companies and electric railway companies have amalgamated to form "The Electric Construction Corporation, Limited," and that the various Woodhouse and Rawson manufacturing companies have also consolidated into a large joint stock corporation.

While in Birmingham, and engaged in visiting the local lions, I went to see Aston Hall, the free museum of the town. In one of the many interesting rooms there, I observed on exhibition, an old fashioned large magnetic machine designed, as an inscription thereon informed me, for use in electroplating. Upon close inspection, I found it to be the first magneto machine ever designed for that purpose; namely, that made and patented in 1842 by Stephen J. Woolrich. This machine was presented to the museum, by Thomas Prime & Son, electro-metallurgists of Birmingham.

Passing through the cathedrals and abbeys of Great Britain, my bosom, like that of Sir Joseph Porter, K. C. B., swelled with pride, to note how these buildings and their precincts were made into a species of mundane Valhalla, where the worthies of the nation, distinguished in war, science or literature were immortalized, and their memories treasured, for the example and encouragement of their countrymen, and as a mark of appreciative acknowledgment of their services rendered to their country.

In Westminster Abbey I remarked the tombstone of William Spottiswoode, electrician and philosopher; while in the abbey and churchyard of Melrose, I noticed respectively the graves of Michael Scott, and Sir David Brewster, one, the friend of True Thomas the Rhymer, of Ercildoun, and the scientist par excellence of the fourteenth century; the other, one of the most fortunate wizards of the nineteenth century; Michael in his day was called a "wizard," but would probably now be called an electrician.

In conclusion, I desire to say that the cordial and fraternal manner in which everywhere I was received by electricians, and by those interested in electrical development, and the hearty hospitality which I received, merit and receive on my part the

profoundest appreciation and the warmest reciprocal feelings of kindness. Never from the moment that I set my feet on European shores, until the moment of my departure, had I any need to feel that I was a stranger in a strange land.

DISCUSSION.

THE CHAIRMAN (Mr. Franklin L. Pope): We have listened with much pleasure, not unmixed I hope with profit, to Mr. Lockwood's interesting paper. In no way is there more to be learned than by comparing with our own work, that which has been done in other countries, by men who are working out these problems on their own lines and under different conditions. By what Mr. Lockwood has said about the English telegraph service, I am reminded of one or two features of it which struck me as being exceedingly convenient. One of them is the method of prepaying the telegrams by stamps. The rate is sixpence for twelve words, counting the address and signature. Each additional word is a halfpenny and the ordinary postage stamps are used indiscriminately for letters and telegrams. The convenience of this appears, as it did to me two or three times, when traveling a long distance on an express train which sometimes does not stop for two or three hours. Having occasion to send a telegram for some one to meet me at a point ahead I have written my message while on the train, put stamps on it, wrapped up three or four coppers with it for "backsheesh," and thrown it off at a way station; and I have always found that it was dispatched and received in due time at the point of destination. That is a very great convenience. There is another feature that will strike our people as a little curious, and that is that in English telegraphing there are no dead-heads. If Mr. Preece sends a telegram he has to put stamps on it, and if Queen Victoria sends a message, she also has to put stamps on. Office messages are sent by mail and paid by postage stamps.

Mr. Lockwood has referred to the construction in England, and the careful manner in which the poles are stayed. That is very largely due to the costliness of timber, rendering it necessary to use light sticks of timber where we would use heavy ones, and stiffening them with stays, so that the general appearance of their

lines is a very large proportion of wires and insulators to a very small allowance of pole. It gives them a rather neater appearance than ours in some respects, but I doubt whether it is much more substantial, although there is no question that the fastening of the wires and of the insulators is much more substantial than ours, and that is particularly the case on the continent.

DR. ALLAN V. GARRATT:—Mr. Lockwood has spoken of the excellence of construction in England. We have heard through the English journals from time to time in regard to the rules and requirements enforced there. If Mr. Lockwood would kindly tell us about the system of inspection for inside electric light wires in England, and the conflicts, if any, between the insurance and the electric light people, it would be interesting and instructive.

MR. T. C. MARTIN:—With regard to that very interesting topic suggested by Dr. Garratt, I think we might have some light thrown on the subject by a gentleman here this evening, and known to a great many of us by his extremely able and lucid writings. I refer to Mr. G. L. Addenbrooke, of England. That gentleman is now on his way home from Australia, where he has been engaged in putting in several plants on steamers. He has been associated with Mr. Ferranti in London in a large portion of his work there. I know of no more interesting work at the present time than that which Mr. Ferranti is doing. It transcends in many respects anything we have done or contemplate doing, and the experience derived from it, I think, would be extremely valuable to us. I think Mr. Addenbrooke's experience in operating the station at the Grosvenor Gallery, and also from running the overhead circuits in the streets, might be profited by in this city, and regarding which various statements have recently been made with more or less truth. But before Mr. Addenbrooke favors us in that way I would like to call attention to one extraordinary omission from the paper. It is probably due to the fact that there was no information obtainable. I refer to the fact that there is no mention in the paper of electric railroading. At the present time in this country we have in something over 100 cities, counting roads, branches and extensions, 179 electric railways. By the end of the year they will operate some 1,200 miles of track. Over that track will run something like 1,800 to 2,000 cars. In view of the fact that we have such an extension here, and that it meets with such universal approval; and that Mr.

Lockwood with all his keen observation—and we know him to be a most observing man—should have seen nothing of the kind whatever to arrest his notice or attention in England, is something phenomenal, and it would be interesting to know what causes that. Does the difference lie in conservatism? Does it lie in local conditions altogether apart from national temperament? Does it lie in the obstructiveness of the local authorities? Does it lie in the caution of capital, or what? What is the reason? There must be some reason and even if it be a bad one, there probably is an argument to offer for it.

Another very interesting point in the paper, was the use of stationary motors. Mr. Lockwood said that he understood the use of such motors to be on the increase in England. I have been at some pains to ascertain whether that is a fact, and I cannot find that the use of such motors is very largely increasing, and the reason seems to be there are no stations to supply the current, and naturally there are no motors. But an explanation has recently been offered by Mr. Van Rysselberghe of Belgium. It is proposed at the present time to introduce electric lighting pretty extensively in Brussels, but Mr. Van Rysselberghe seems to think there is no use for a central station. In his opinion everybody who wants the electric light should generate the current himself and supply himself, and for that reason in place of a central station, as we know it in America, he proposes to put in hydraulic motors to drive independent plants, these hydraulic motors to be worked by the high-pressure hydraulic service of the city. Mr. Van Rysselberghe, in explaining his system recently, said that he did not think there was any reason at all for the introduction of the electric motor on the Continent; that the European consumer wanted something simpler than the electric motor. How he would get it, I find it hard to conjecture, but such he said to be the case. I have listened with a great deal of interest to Mr. Lockwood's paper, and would be very glad indeed if he could give us light upon one or two of these points which I have suggested. I would suggest that Mr. Addenbrooke's experience with regard to the work in connection with the Ferranti installation in London is of the most interesting and valuable nature; and now that the Deptford station is going into operation, and is a practical development of the results obtained at the Grosvenor Gallery, I think it would interest us to know what he has done there himself.

MR. G. L. ADDENBROOKE:—I should be only too glad to say anything that I can, premising my remarks with the statement that I have been away from England very nearly a year, chiefly in Australia, and that I came here to find out what they had been doing in England. I rather came here to hear the latest news than to be able to say anything myself. It is a great pleasure to have heard Mr. Lockwood speak so appreciatively of the overhead work in England. We have felt satisfied ourselves that our overhead work had a good many defects in it, but in England we look a great deal to people in America, and Mr. Lockwood having such thorough experience, and speaking so well of what we have accomplished, it gives us a great deal of gratification, especially as I happen to have been connected with the work in various capacities myself, both telephonic and electric lighting. In referring to overhead electric light work I am speaking rather of the past than of the future, because I think you are aware the commission appointed by the Board of Trade, which has lately gone into the whole matter, has formed a set of regulations under which the whole of the electric lighting in London is to be placed underground as soon as possible. No additional overhead wires are allowed to be placed, except such as may be agreed upon between the inspectors and the various companies, and the central station companies in London are now very hard at work laying down mains. However, there is no doubt a good deal of overhead work will be required for various purposes, and as you have so much overhead work here perhaps it might be worth while to explain our practice. First of all, we have not been allowed to plant posts in the streets at all, except in country roads. Within the boundaries of towns it is an absolute rule that no posts can be fixed in the streets. If we want posts we must put them in people's back gardens and in vacant lots, etc. Of course this has required that the majority of posts be placed on the tops of the houses. In foreign towns they have also had to go on the tops of the houses very largely. They have adopted one construction; we have adopted another. On the Continent most of the roofs have a very steep slope, and are tiled so that it is quite impossible to walk on them, and, of course, people do not put up stronger roofs than they can help—only strong enough to support the tiles and stand the wind, but not strong enough to support telephone posts. On such buildings they use two long pieces of timber, and form what they call a horse. That con-

sists of a number of uprights and a lot of cross frames. I think you have some of them here. Nearly the whole of the work is done in that way. In England we went to work in quite a different way. As Mr. Lockwood said, it is not unusual in London, at any rate, in overhead work on houses, to have wires arranged horizontally. As a rule there is but a single span. We have first of all what we call a chair. That is an iron casting weighing from fifty to sixty pounds that goes on the top of the roof. From this rises a wrought-iron tubular pole. These tubes are carefully made to specification; they are about three inches internal diameter. It is usual to put up a pole of not less than 18 feet, but they range as high as thirty. In such cases as the latter, it is usual to have two or three poles, one inside the other, each pole having a collar and a bolt going through. These poles are simply stayed to the brickwork. Heavy spikes are driven into the brickwork, and it is rather an agonizing process for the house as you may imagine, but somehow men have a way of doing it, and they drive spikes eight inches long into the brickwork. It is wonderful how the masonry stands it. I may say I have seen some very large cracks occasionally. The wall itself will sometimes split out in the plaster joint. Each pole will have at least four of those stays under ordinary circumstances, and then of course it has to be stayed in accordance with the rules.

When I came to America and saw the mass of wires running in all directions, it reminded me of what we call the early days of telephones in London, and we had so many faults with wires then that I could not understand how things worked. So I looked about me and I find apparently the difference is that we think nothing of a span of 120 yards. Sometimes in telephone work we go 200 yards, and 150 yards is considered very little for a span of wires. Of course in running wires that distance there is a very considerable amount of sagging, and in a wind they are liable to come in contact with each other, and they are also apt to get out of regulation; that is, wires put in when the weather is hot, and wires put in when it is cold, and brought into unison, will get out of unison occasionally. So that, perhaps, accounts for the reason why you are able to run such a mass of wires about the streets and yet get along at all.

Then we come to another point, what we call "leading in"—that is, taking the wire from the pole to the office of the sub-

scriber. In England that is always done with gutta-percha covered, wire, as the people who began telephone work in England were those who had had experience with telegraphs. This wire costs about three or four pence a yard. It has a thick covering of first-class gutta-percha. Of course this insures immunity from faults and leakage, and it is in some cases taped and in some cases braided. But if it is taped, it is very strongly taped, and the whole thing is what you call a very excellent job.

One very great reason why tramways perhaps have not made more advance in England is that posts are not allowed in the streets. Perhaps in the country districts they might be allowed, but without a lot of formalities, etc., before town councils, no leave to put up posts will be given. I think it is highly probable it will come, but still it will take time. On the other hand, notwithstanding what has been said about electric railways here, I know perfectly well you have nearly a thousand miles in operation. I have just come from San Francisco, and stopped there some days. I stopped at Denver and Salt Lake City, and at Chicago, and at Pittsburgh, and at Philadelphia, and I have been here some days. At each of these places I have done all I could to see electric tramway work. I happened to see a car in the distance at Salt Lake City. They were putting up the wires in Pittsburgh. I was kindly shown a car running with accumulators here yesterday. I called on the Sprague Company, and they said they had nothing which they could show within a hundred miles of New York, so that although you have a great deal, yet your country is so large, and the work is so scattered around, that it does not show much, and I think, perhaps, the same applies to England. We certainly haven't got anything like that length of track, but there are a lot of little tramways running about there which I think may be called to some extent the pioneers of tramway work. For instance, there is the Blackpool tramway, which has been running several years. There is the Portrush tramway, in the north of Ireland, which I think was the first electrical tramway ever erected. There is a small tramway running along the Brighton Beach which has been very popular and has been running six years. There are two or three companies in England operating experimental lines now in a small way, and certainly without going out of your way to see them you probably would not succeed in doing so.

Passing on to electric lighting, beginning at the station, at the

Grosvenor, we were working with 2,500 volts, and the dynamos were so perfectly self-regulating, at the period I was there, and with the load they had on them, that all regulating appliances were practically unnecessary beyond a sensitive governor on the engine and perhaps an electric governor on the engine and something to keep the exciter in order. All you have to do is to keep your dynamo turning round at the same rate. The circuits were so large that the putting on of lights or taking them off practically made no difference, and we always arranged things in such a way, that we never allowed, if we could possibly prevent it, any large circuits to be run into public buildings or theatres, or anything like that. That is to say, we always contrived that not more than 50 or 60 lamps should be turned off at the same time. Of course a man going around a building could turn off four or five switches, but while he was doing that the engine driver would have a chance to look around. The circuits were so large that 50 or 60 lights on or off practically made no difference, and most of the regulation was simply done by the engine driver controlling his engine. Of course that simplified matters very much.

The overhead work is done on very much the same line as telephone work, only the poles are shorter; sometimes they are not more than twelve feet, but as a rule they run to eighteen feet. Near the top of the pole is a clip, and an insulator is secured to this by a strap and nut, as was formerly done in telephone work. From here to the next pole, which might be as much as 100 yards away, but preferably not more than 60 or 70, a steel suspender of seven No. 14 gauge wires is run, and that is bolted up pretty tight. I might say it is a very difficult task, making up these steel suspenders—turning the things around to make a good tight way-leave job. Below this there was another similar insulator and to this the cable was made fast. The cable ran below the suspender. Most of the main circuit cables were nineteen No. 15 gauge, the branches being about seven No. 16's, and so leading off to seven No. 20's, or something like that for a few lights. You will see that, first of all, this steel suspender is absolutely insulated. That suspender will practically stand almost any voltage you could put on it. The cable itself was insulated in the same way. Supposing it was a bare wire there was always three inches of china between it and the nearest earth. These cables were first of all insulated with little ebonite

rings, by which they were suspended, having a little split ring which allowed them to run along the suspender. Afterward Mr. Ferranti adopted raw hide leather thongs, which were slipped over the cable. The cable was all wound up on a barrel or any convenient means. This cable was taken up to the pole, the first ring put on and the cart taken to the next pole. If you were going to run half a mile of cable you would have a man to almost every pole. They would haul the cable, the men putting on the rings as it went by. Of course it is a slow process, but it is fairly satisfactory when it is done. First of all, you have the insulation of the cable; secondly, you have the insulation due to the raw hide thong; thirdly, you have the insulation due to the suspender; so that altogether you are fairly safe. Supposing that suspender goes; the cable at first is bound round the insulator quite firmly enough. It is no use spending a lot of money on insulation and getting tests in a test room if you spoil it before it is up. But in this case these insulations were due to the cable that was wound around them and lapped across so as to avoid as far as possible cracking the insulation in any way. Therefore, unless the pole came down bodily, there was not much chance of an accident happening, and if the pole came down bodily, this insulation, as has proved to be the case in more than one instance, would be quite sufficient to keep everything right until the fault was remedied. There is another advantage in having this suspender. Our poles were usually lower than telephone poles. The steel suspender the telephone people were at liberty to draw their wires across as much as they liked. Occasionally they would get a wire underneath, and when it was sagged, haul it a few minutes, but they soon learned to leave off doing that. Of course, working with the alternating current and on a parallel system we have no confusion of wires such as there is here. A single circuit was generally sufficient for most of the requirements. In a few instances, where lines were going into different districts, owing to difficulties in getting our way-leaves, there might be four wires, but no more. I put it to American engineers whether this is not really the better way of doing things. The number of circuits you may get by running arc lamps, or anything else, in series becomes in time stupendous; and I know in working in telephone work underground what a bother it is to be mixed up with conduits and the remedying of faults. In adopting a parallel system you get rid of that, and

you get simplicity right away. When we wanted to take the current off we put another of these brasses on and another set of insulators and we took what we called "T's" out of the cable at a few feet from the post. These, of course, were small wires; they were carried down the side of the house, the insulators standing well out from the wall, and as a rule they went through the walls in china pipes, especially made for the purpose; that is to say, we do not simply take a chisel and ram a hole through a wall anyhow and just put the wires through, as I saw them doing in Pittsburgh. It was rather a costly job, I must say. We finished up with Portland cement afterward, the wire coming to a cut-out, which by the regulations of the fire insurance companies was either put on slate or on a brick wall. These wires were not allowed to be put on wood or near wood. Such things were not allowed as bringing a wire through the framework of a window. That would not be tolerated. When they come inside they come almost immediately to the cut-out, and even if there happened to be a ceiling three feet above, the fire insurance companies insisted on a large sheet of asbestos being fixed against that. From there we box our converters inside of iron bricks which were fixed in the wall, and on the way to the converter there was the usual switch for cutting the whole installation out. Of course the switch was in many cases not used at all by the householder. In fact, it was more for the convenience of the central station people than for the householder. They turn off their lamps on the local circuits.

Now, before going further, I would say something of the class of wire that was used. I think the reason that English work has taken the particular line it has, is almost entirely due to the fact mentioned by Mr. Lockwood, that England has done all the cable work so far. We were accustomed to expensive wire for cable work, and consequently we did not object to paying £250 a mile for such a cable as nineteen 15's, which I dare say you would think a good deal here. The class of conductor we used was made of nineteen No. 15's, tinned on the outside. This was then wrapped round with three wrappings of fine rubber, such as you use in making joints. Then on the top of that comes what is called a white rubber, that is wrapped on two or three times spirally; outside of that there is another of what is called black rubber. These two outside rubbers have vulcanized material mixed with them. When that cable is made

to the thickness of insulation which we used on these cables, and do use now—one-eighth of an inch of rubber—the cable is then put in the tank and vulcanized. Now, there is one point that cannot be too strongly insisted on, and which is this, that it is no use having an expensive cable like that if you are not going to protect it thoroughly. India rubber will stand fairly well under water. It will stand fairly well in moist weather, but will not stand in dry air; and it will not stand in alternations of wet and dry. If you will expose the rubber to the air it will in time perish. It is also liable, if it rests on anything sharp or sharply rounded, to get very thin at that point.

The way we went to work was this: On the outside of that cable is a fine waterproof tape, which is vulcanized on to the material and absolutely forms part of it. How much further you go depends on circumstances, but a general rule was to take a compounded tape, that is a strong linen tape twilled and dipped in some compound of ozokerite, and this was wrapped around in one or two coatings. Outside of that we carefully put on a strong braid of yarn, and the whole was thoroughly saturated with the compound. You have then done about all you can do, and I may say that in London I believe that there are three or four miles of cable of that class which has now been lying in iron pipes carrying a tension of 2,500 volts without any accidents. The cables are simply drawn into the iron pipes and lie side by side. I know that the Silvertown people four or five years ago laid down such cables as that for arc lighting throughout their works. The grounds of their works are fairly saturated with various mixtures, yet it has given them no trouble at all since. I cannot help thinking that if your cable is properly protected that it will not give trouble. That cable, of course, before it leaves the manufacturer, is carefully tested. I have spent months in testing telephone and electric light cables of that character. This class of cable manufactured by the Silvertown Company would test from 2,000 to 8,000 megohms to the mile at a temperature of 75°. If you put the testing current on to a cable like that it flows into the cable with a great rush, and then the rush diminishes, and you gradually see the spot of light coming back. One should always watch that spot of light for ten minutes. Sometimes it will give a little kick, and that will denote that something is not quite right. But the Silvertown people have told me, and I have known, that they have manufactured in submarine

cables as many as seventy miles of cable without locating any fault that they were obliged to cut out.

As to installation work, that is also done with first class rubber covering thoroughly vulcanized. It usually depends a good deal on the fire insurance inspector. One man will pass one thing and another will not pass it. You have got to know your man. Mr. Musgrave Heaphy first succeeded in imposing his rules more or less generally, and work is now, I believe, fairly up to his standard. His standard means that no wires are to be within an inch of each other in wood casing; that wood casing is used everywhere; that there is no exposed wire; that there are cut-outs to every two or three lamps; that the cut-outs have all slate or porcelain bases; that all switches have porcelain solid bases, and that no screws communicating with the current are allowed to come in contact with woodwork at all.

No doubt we have sacrificed rapidity of progress to some extent, and we have had a lot of trouble; still there has been immunity from accidents, which is very gratifying, and the work will stand. There is no doubt that the people, when they put electric lights in their houses, have an idea that it is going in just the same as gas fittings, but a good deal of the electric work put in in past years I do not think would last as long as fair average plumbing. I am very much obliged to you for listening so appreciatively.

THE CHAIRMAN:—I would like to ask Mr. Addenbrooke his opinion on the proposition which we have heard considerably of within a few weeks, that while there is no particular difficulty in insulating a direct current of 3,000 or 4,000 volts, it is absolutely and entirely impossible by any known means of insulation to insulate an alternating current of a thousand volts. What is your experience as to that?

MR. ADDENBROOKE:—It is not a subject on which one likes to make a random shot—and my experience was pretty fully stated in the London *Electrical Review* three or four years ago. I do not think there is anything whatever to show that the alternating current will break down insulation quicker than a continuous current. I know a great many statements are made on the subject. I do not know of any one in England or America who has made a careful series of experiments on that point. We all know that the alternating current will not produce anything like the arc that the continuous current will.

A continuous current of a thousand volts will produce an arc—I would not like to say how much longer than an alternating current will produce. We know that a cable does not receive the full charge of electricity at once, while you can see the movement of the galvanometer an hour after the cable has had the current on, but of course the great rush occurs immediately. Still it takes a very appreciable time, and in the case of an alternating current, we will say alternating 200 times a second, it is quite conceivable—I do not say that it is a fact, but it is worth putting forward—that the insulating substance around that cable has not time to get sufficiently polarized to allow the discharge to pass through quickly before the current has turned in another direction and has depolarized it. I do not say that this is a correct view. It is a thing that requires to be gone through very carefully. From all the observations I have made and what I have heard on the question of insulation, I think that an alternating current will not go through more quickly than a continuous current.

THE CHAIRMAN:—The English telegraphic engineers have always taken the ground that a submarine cable was less injured by an alternating than by a continuous current. They have used the double current system on defective cables, in preference to the single current system, which will tend to prove, I suppose, that they apprehended more trouble from the breaking down of the insulation by the continuous current than by the alternating.

MR. LOCKWOOD:—The hour is late, so I shall make my remarks in reply to questions very brief. The Secretary has mentioned the subject of pneumatic tubes, and that very little or nothing had been said in my paper regarding them. I think, perhaps, I may be excused for the reason that there was very little or nothing to say. It is true that pneumatic tubes are much more extensively used by the British telegraph authorities than they are used here, because it is apparently one of the maxims of the British telegraph authorities that it takes a longer time to deliver a message than it does to send it. I am sure that the same view is borne out by the experience of every one of us who has ever had occasion to send or receive a despatch, and so instead of filling up the large cities such as London, Liverpool, Manchester and Birmingham with telegraph sub-offices, at about every hotel and every ten blocks, they have organized a system of pneumatic tubes which is very like that of the Western Union in New

York, but on a much larger scale, and as a general thing, they send their messages in packages in a pneumatic tube from one point to another.

In respect to the inquiry made by Mr. Garratt concerning the relative methods of inside construction in electric lighting, and how they get along there with the inspectors, I think that has been sufficiently answered by Mr. Addenbrooke.

Mr. Martin thought something should have been said regarding the electric motor railway service. There are not anything like as many street car roads as there are on this side. But it is only within the last twenty-five years that street car railways were introduced into England by Citizen George Francis Train, and they called them tram roads, not from any connection with Mr. Train, but because there were tram roads in collieries, before Mr. Train was heard of. During the twenty-four years I was absent from England, I found there had been a great advance in street railroad business. But they are not a fast nation. In England they would rather do a thing well once than do it fast a dozen times. So they found the horse car a pretty good thing to stick to, and they have made more of it than we have done, because they make all the cars double deckers; not only that, but they use steam dummies to a very large extent, and between Birmingham and Soho and other districts I find they use the traction cables, and it gives good service. One of the electric roads I had the pleasure of traveling on was about a couple of miles long, and situated on Brighton Beach. It is a very poor kind of a thing to look at, but it is in a safe location—on the sands of the sea shore, and it does not trouble a single telephone wire. The current passes through the two rails. The Port Rush road is still there, and, as I understand, is doing good service. I had not time to see it. After all is said and done, the main reason that electric motor roads, operated as we operate them with a single wire overhead are not more common, is the reason mentioned by Mr. Addenbrooke, reinforced by the very potent hand of the central government which knows that the operation of such an electric railway in such a way would be a great deal of a nuisance to its own telegraph wires, and would mean death and destruction to all telephone wires in the kingdom, which will possibly be all government property some day. I asked Mr. Preece about that, and he reminded me that he had presented to the Institution of Electrical Engineers a paper

showing very clearly the evil results to all electric systems operating sensitive instruments, of railway or electric light systems using the earth for a return. I also inquired of a gentleman well informed in electrical matters, why the electrical railways were not more used with the overhead wire, and he said because they would not be allowed. I thought that was a very good, solid reason, and when I told them how they were being sown broadcast through the land here, and how, when harmless telephone companies remonstrated, they were universally met with the cry that the telephone companies wanted the earth, he said, "That is very true; they want the earth here also, but they want it to work on like any other peaceable mortals, and they do not propose to allow that a tiger has the same right to walk the earth that a man has." And that seems to me the principal reason why the electric railway has not made more progress than it has in England.

I do not know that I have anything more to add except to express my gratification at the very lucid demonstration made by Mr. Addenbrooke. He said one or two things that I should like to have said myself, but I am going to stay in the country and he is not. I thank you, gentlemen, for your very kind attention.

THE CHAIRMAN:—In closing this very interesting discussion, I will take the liberty of expressing the thanks of the meeting to Mr. Addenbrooke for the information he has given us, and will announce that the next paper before the Institute will be read on the evening of October 29th, by our fellow member, George B. Prescott, Jr. His subject is "Some Methods of Regulating Accumulators in Electric Lighting."