1893.

NEW ZEALAND.

PUBLIC PETITIONS A TO L COMMITTEE

(REPORT OF, ON THE PETITION OF THE DUNEDIN CITY AND SUBURBAN TRAMWAYS COMPANY, LIMITED, *RE* USE OF ELECTRICITY AS A MOTIVE-POWER, TOGETHER WITH THE PETITION, AND MINUTES OF EVIDENCE AND APPENDIX).

Brought up on 3rd October, 1893, and ordered to be printed.

REPORT.

PETITIONERS state that they have entered into arrangements for the disposal of their tramways to a new company, who make it an essential condition that electricity on the single-trolly system shall be adopted as the motive-power. That, on application to the Public Works Department for the issue of an Order in Council permitting the use of electricity as the motive-power, under the single-trolly system, such permission was refused, on the plea that the use of the ground as a return-circuit would interfere with the telephone system.

They pray that they be not debarred from adopting the single-trolly system as a motive-power for their tramways.

The Committee having considered the evidence given before the recent Parliamentary Committee in England on a similar question, and all the other evidence submitted in connection with the petition of the Dunedin City and Suburban Tramways Company (Limited), asking permission to use electricity on the single-trolly system as a motive-power, beg to report as follows:—

1. That while the request of the petitioners, that the Government shall at its own cost insulate the wires of its telephones, and take such other precautions as may be deemed necessary for making their exchange a self-contained system, is clearly untenable at law, the Committee are of opinion that, owing to the delicacy of the instruments employed, it will soon be necessary to alter the telephones in all large cities to the metallic-return; and they therefore suggest, in the interests of the public, that the Government should as far as possible give facilities to companies desirous of establishing electrical tramways. The fact that the Government is first in the field, and (as acting under statute) presumably within their legal rights, should not, in the opinion of the Committee, be considered to give them paramount right over the streets, which were primarily established, not for telephone purposes, but for the purpose of facilitating travel and transportation; they belong entirely to the Corporations for the above purposes, and any use of them for telephones must necessarily be considered as subservient to this original easement of the public for highway purposes.

2. That it is desirable, in view of the facts disclosed in the evidence, that proper precautions should be adopted to safeguard the rights both of the municipal bodies and the general public, and, with this view, that any company desiring to introduce electrical energy for the purpose of traction should have to submit to conditions similar to those contained in the clause proposed by the English Parliamentary Committee (see Appendix H), or such modification thereof as further experience may have rendered necessary; but the Committee are of opinion that these conditions should not be such as to practically give the Government a monopoly of the ground-circuit, or to impose such limitations as would be practically prohibitive, having regard to expense and the commercial prospects of the undertaking, both in construction and working.

A copy of the evidence taken is herewith attached.

C. H. MILLS,
Chairman.

3rd October, 1893.

PETITION.

To the Honourable the Speaker and Members of the House of Representatives in Parliament assembled.

THE PETITION of the DUNEDIN CITY AND SUBURBAN TRAMWAYS COMPANY (LIMITED), of Dunedin, humbly sheweth,—

1. At the end of last year arrangements were entered into in England for the disposal of your petitioners' tramways to a new company, in which the shareholders of this company were to take paid-up shares for their interests.

2. An essential condition of the arrangements is that electricity on the single-trolly system be adopted as the motive-power.

3. Owing to the cost of horse-haulage (the motive-power in use by your petitioners) the tramways are and have for several years been carried on at a loss, and, unless electricity can be substituted as a motive power, your petitioners will not be able to continue to run the service.

4. The single-trolly system was selected after full inquiry, and because it was recommended as the best by Messieurs Siemens Brothers and Company, the most eminent of electrical engineers in England. It has been introduced by them into Hobart. It has, moreover, been judicially pronounced by law-courts, both in England and America, before whom the merits of rival systems have come for examination with reference to their effect upon telephone wires, as the best that has been devised. It is the system that is more extensively used than are all other systems put together, and has proved itself practically, scientifically, and commercially a complete success. In this connection your petitioners would respectfully refer to the recent case in Leeds of The National Telephone Company *v.* Baker.

5. Your petitioners had, before the said arrangements were entered into, obtained the consent (informally, but by a resolution) of the City Council of Dunedin to the adoption of electricity as the motive-power.

6. On the 19th of January your petitioners sent to the Public Works Department the draft of a proposed Order in Council, varying their existing Orders in Council so as to permit of electricity being adopted as the motive-power. Plans and specifications of the proposed works were sent together with the draft Order. These were sent with the request that they should be examined at once, so as to save time, in anticipation of the consent of the Councils of the City suburban boroughs being formally obtained.

7. These consents were all obtained shortly afterwards, after careful consideration and inquiries, in particular by the City Council.

8. On the 24th of February a letter was received from the Public Works Department setting forth a number of requisitions made by the Engineer-in-Chief.

9. Early in March, Mr. Hay, as engineer for the promoters, and Mr. Murray, the representative for Messieurs Siemens Brothers and Company, who had charge of the construction of the Hobart electric trams, personally saw the Engineer-in-Chief in Wellington, and answered to his satisfaction verbally, and in writing, all his requisitions and inquiries.

10. In the letter forwarding the requisitions of the Engineer-in-Chief it was announced that the Law Officers doubted if the Government had power to vary the Orders in Council as proposed, on the ground, as your petitioners then understood, that "The Tramways Act, 1870," did not extend to electricity as a motive-power.

11. Much correspondence and several interviews ensued, in regard to the Law Officers' opinion, and ultimately, on the 13th of May, your petitioners were informed that the Law Officers could not advise the Governor to issue the Order in Council as proposed. The difficulty of the Law Officers arose, as your petitioners ultimately ascertained, from the interpretation given to the term "road" by the Tramways Act. As this term did not include footways, it was considered by the Law Officers that power could not be given to erect the necessary posts there, although your petititioners contended that the local bodies who had control of the streets had given the necessary authority to do that. The Law Officers, however, justified the opinion held by your petitioners and the local bodies that the Act did extend to electricity. The only difficulty was the technical one of interpretation.

12. The Honourable the Minister for Public Works at once met your petitioners and undertook to introduce an amending Bill to remove the difficulty. As the Law Officers were pressed for time, your petitioners were requested to get the Bill drawn and submit it. This they did, framing the Bill as a general Act and not confining it to their own undertaking merely.

13. Meanwhile an amended Order in Council embodying provisions to meet the requisitions of the Engineer-in-Chief had been sent in, and on the 18th of May last your petitioners were for the first time advised that the Telegraph Department objected to your petitioners using tram-rails as a return-circuit for the electric current, on the ground that the doing so would probably destroy the Telephone Exchange in Dunedin and suburbs; and your petitioners were asked for proposals to meet this objection.

14. On the 22nd May your petitioners made the following proposals to the Public Works Department:—

"The Tramway Company proposed to use the tram-rails for the return-circuit, and for that purpose to connect the joints of the rails with copper strips. If this course should be found to interfere with the telephone system it would only do so along those portions where the tram-lines and the telephone wires are in the same street. In those parts where the telephone wires and tram-lines concur, the telephone posts and wires could, at no great expense or inconvenience, be removed to a parallel street. Where there is no convenient parallel street, as in the North-east Valley, a return-wire could be fixed. If, therefore, the Order in Council makes provision for the doing of these things, if it is found the telephone system is affected, we submit the objection will be effectually dealt with.

"We shall be obliged by your letting us know at the earliest practicable moment if these proposals are acceptable. If they are not, we have the honour to submit that the department should formulate what will be considered sufficient, or else no conclusion will ever be arrived at.

"Of course these proposals will affect the contract price which had been obtained from Messrs. Siemens Brothers for the equipment, and may therefore, if too costly, lead to the abandonment of the whole scheme, unless the Government will help.

"In dealing with the matter, it should be remembered that the tramway system is a public convenience quite as much as, if not more so, than the telephone system."

15. On the 26th June your petitioners were advised that the Telegraph Department required that the double-trolly system should be adopted, with careful insulation, to see that none of the current should reach the rails or the earth along the route of the tramways.

16. Your petitioners humbly set forth that, if these requisitions are insisted on, the project of adopting electricity as a motive-power must be abandoned, as not only will the cost of complying with them be too great, but what is much more important, the double trolly is too complicated.

17. Your petitioners humbly submit that they have a grievance, in that, after all the trouble and expense necessary to effect the arrangements referred to, and after all the local bodies (five in number) have gone through the required formalities, and given their consents, the Telegraph Department should, at the last moment, have made the requisition in question. Four months have elapsed before the objection was mooted.

18. Your petitioners further humbly submit that the attitude of the Telegraph Department is unreasonable, and that that department should, at its own cost, insulate the wires of the Telephone Exchange, and take such other precautions as they may deem necessary for making their exchange a self-contained system.

19. Your petitioners humbly submit the following considerations in support of their contention:—

(1.) That, for the reasons set out in paragraph 3 of this petition, the requisitions are unreasonable, and are made without a due appreciation of the advantages of the single-trolly system.

(2.) That by making these requisitions the Telegraph Department is, in effect, claiming a paramount right to use the streets for telephone purposes; whereas the streets are primarily designed for pedestrian and vehicular traffic, which it is the object of the electric tramway system to promote.

(3.) That the Telephone Exchange is not a matter of general concern like the telegraph, but of local convenience only, like the tramways, and less so than the tramways as regards the number of the public benefited.

(4.) That for the tramways rents are paid to the several local bodies for the use of the streets, whereas the Telephone Exchange uses the streets without contributing in any way to the local bodies' revenues.

(5.) That the Telephone Exchange has been constructed on a principle suitable only where no other electric agent is used concurrently in the same or adjacent streets; whereas it should be, as your petitioners humbly submit, a self-contained system, and not such as to preclude local bodies from improving by electric agency the traffic of their own streets.

(6.) That, apart from the establishment of any other electric agency in the streets, the Telephone Exchange is at present defective, because not properly insulated.

(7.) That the telephone system will be appreciably improved by proper insulation apart from tramway or other electric interference, by the removal of present buzzing and cross-talk, inconvenience to telephone subscribers.

(8.) That telephone companies in other parts of the world have to insulate their exchanges at their own expense.

(9.) That the Telegraph Department are not authorised by law to discharge their electric currents into the public streets, and the present use of the streets for that purpose is unlawful.

(10.) That, if the local bodies desire to discharge such currents into the public streets, the local bodies in which the streets are vested, and not the Telegraph Department, have the paramount right to do so.

20. Your petitioners also humbly submit that under the Tramways Act the propriety of the system proposed ought to be considered on its own merits, and not with regard to what your petitioners humbly consider the side issue, of its probable effect on the Telephone Exchange.

Your petitioners, therefore, humbly pray your honourable House to take the foregoing matters into consideration, and make provision affirming that the local bodies, whose licensees your petitioners are, are entitled to the paramount right to use the streets as a field for the discharge of electric currents in connection with the use of electricity as a motive-power on tramways, and that, if the Telephone Exchange will probably be affected thereby, then the Telegraph Department should bear the expense of insulating the telephone wires and taking any other precautions requisite to present the exchange from being affected.

And your petitioners will ever pray, &c.,

The Common Seal of the Dunedin City and Suburban Tramways Company (Limited), was hereunto affixed, this 5th day of July, 1893, in the presence of— (L.S.)

GEORGE FENWICK,
HENDERSON LAW,
JAMES HAZLETT,
Directors of the said Company.

MINUTES OF EVIDENCE.

THURSDAY, 20TH JULY, 1893.—(Mr. C. H. MILLS, Chairman.)

Mr. GEORGE FENWICK, Chairman of Directors of the Dunedin City and Suburban Tramway Company (Limited), attended and gave evidence.

Witness: Is it the wish of the Committee that I should make a statement, or that I should answer questions put to me by the Committee?

The Chairman: Perhaps it would be more convenient if you would first make a statement.

Witness: I wish to say, with regard to this petition, that the petitioners put forward their claim in as complete and exhaustive a manner as it was possible to do, as at the time it was drawn up there was no intention that I should come to give evidence before this Committee, or that any one should be sent here for that purpose. Practically it contains all the main arguments in favour of the conclusions at which we have arrived at, viz., that the single-trolly system is the best system, and the system we ought to adopt. On the general question of the right of electric traction companies to use the streets for the discharge of their return current, we know that decisions have been given in England and America establishing that right. There was a test case in England, which was brought by a telephone corporation—not a Government institution, but a private corporation—to restrain an electric tramway company from discharging their return current into the streets. This went against the telephone company. That was a case on all-fours with our own. The tramway companies were using the single-trolly system. They elected to use that system after having made exhaustive inquiry, as we have done, as to the other systems in vogue. We have been engaged with the investigation of this subject for the past three or four years. We have received a great deal of information from America, and other places. We have compared these reports, and as the result we have come to the conclusion that the single-trolly system is the best system, and indeed, the only system that ought to be adopted. The testimony in its favour, as regards its efficiency and the expense of working, is very great indeed as compared with the double-trolly system. It is the system which the English electric tramway companies have adopted. The engineers say that the double-trolly system does not work well, that it is more costly both in its introduction and its mode of working than the single system, and, in short, that there are greater drawbacks in working it as compared with the single-trolly system. For these reasons we have come to the decision to adopt the single system. The correctness of our decision is borne out by the experience of Messrs. Siemens Brothers and Company, the great electrical engineers and manufacturers. We have arranged, through intermediaries, to adopt it, and Messrs. Siemens and Company are to carry out the work. The basis of our negotiations for the transfer of our rights to the new company is upon the single-trolly system, and unless we are supported in our claim to the right to use the streets for our return current all our negotiations will have been fruitless, and our proposals will fall to the ground. Bearing on this subject, I should like to show the Committee one of the most recent publications showing the vast progress made in the use of the single-trolly system in America. The Committee will see that there are no less than 4,700 miles of electric tramways worked under that system in the United States. [Documents put in.] All the thriving American cities, after the most careful research, have adopted the single-trolly system. The double-trolly system has been, so we are informed, almost entirely discarded. I cannot give you more conclusive evidence that we ought to introduce this, the most perfect system that has been devised up to the present. I should like to say a word about the telephone system generally. We claim that it is an imperfect system, although a great deal of money has been spent upon it. It seems to me that tramway companies should not be also driven to use an imperfect system when a more perfect system can be obtained. It is open to the department to make their telephone system a perfect one.

1. *The Chairman.*] So that it would not conflict with the others?—Were the Telegraph Department to insulate their telephone system there would be no conflict. We know from experience that the telephone service is at present very imperfect, and that, owing to cross currents, private conversation is overheard, so that it is not safe to send an important message along the telephone. If I were engaged in any important negotiations I should certainly not use the telephone. We have all heard of messages overheard by persons for whom they were not intended. That cannot be avoided under the present system. The Telegraph Department makes a very handsome profit out of the public, to which the telephone no doubt largely contributes, so that I think a portion of this profit might be applied to making the telephone service more complete than it is at present. I may say, further, that I believe those who use the telephone would themselves not object to pay a small addition to their annual subscription to have a perfect system. I feel sure that subscribers would pay a pound or thirty shillings a year more if there were a perfect system at work. It would relieve them of the doubt they now have as to the privity of their messages. Assuming that it would cost £10,000 to replace the present system with a new one in Dunedin, an increase of £1 per annum by the six or seven hundred subscribers there would give an ample interest upon the outlay.

2. *Mr. Earnshaw.*] I observe that there are a number of places mentioned in those papers which you have laid upon the table from which it appears that the route goes right through important centres of population?—Yes, through many of the principal cities in the United States.

3. *Hon. Mr. Reeves.*] Do you, Mr. Fenwick, base your preference for the single-trolly system on its relative cheapness?—Not entirely, but partly on that. We base our claim mainly on the

fact that all our negotiations have been on the basis of the single-trolly system; also upon the fact that the double system does not work so well. Seeing that it has been discarded in the United States, and the single system has been adopted in its place, we wish to adopt the most perfect system.

4. Then your petition is really to enable you to sell to an English company?—That is one of the main things; but we base our argument, of course, upon a higher ground than that—the ground of what we conceive to be our rights.

5. But you do recognise that to enable you to effect your object in that respect the colony, or, rather, the Government, would have to spend a considerable number of thousands—£7,000 to £10,000—in altering the telephone system?—Yes.

6. Not wishing to anticipate your case, which I admit you should develop according to your own interest, could you give us any assurance that the single-trolly system will be any remarkable improvement as regards the conveyance of the public on the present service?—Yes; we have no doubt on that subject, for that is the point to which we have been devoting our attention for the past three or four years. We have the experience of Siemens Brothers and Co., and also written reports, and the conclusions of an experienced tramway engineer, who went to New York purposely to inspect the various systems. He was delighted with the single-trolly system. He went to New York prejudiced in favour of the cable system, as in use in Melbourne, but after an exhaustive investigation was satisfied the single-trolly electric system was the best. After staying in New York for a considerable period, and after visiting other cities with the same object, and after the fullest investigation, he decided that the single-trolly system was the best. There is abundant testimony as to the advantages of adopting the single-trolly system. In the United States it would appear that in every town where it has been adopted there has been a steady increase of traffic. The public there have thoroughly appreciated the change, and in every instance a large increase of business has resulted.

7. What is the system in Melbourne?—Cable. It is, no doubt, a splendid system, but was prohibitive in its cost.

8. There is one point I want to get at. All you have heard from the engineer you have referred to on the advantage of the single-trolly system is consistent with this—that he looked at it from the point of view of the proprietor of a tramway, and not from the point of view of the public. Tell us, in what way will this improve the convenience of the public?—We are working under a horse system, and the result is that after a very short service the horses are knocked up. It is very heavy work for them. There is a hill in Dunedin up which the cars are taken heavily laden a great many times a day. It is frequently the case that the horses cannot get up. Moreover, the streets will be kept cleaner, as horse traffic causes the streets to get very dirty.

9. Will the speed be greater?—We run a quick service as it is, but we anticipate being able to increase the speed.

10. Do you anticipate an increase in the number of passengers?—Yes; we anticipate a large increase.

11. Has there been any proposition made by your friends to help the Telephone Department to bear the cost?—No; no proposals were made, because we never knew what the cost would be.

12. You see the peculiarity of the position that arises in asking the Government to assist a private, or, at all events, only a semi-public corporation to sell their property at an advantage to a foreign syndicate—for reduced to common terms that is it. Is there any possibility of your defraying a portion of the cost?—We do not look upon it that the Government would be assisting a merely private or semi-public corporation. We regard this as a public question. We say that from the mere accident of the Telephone Department being the first in the field they have got a certain status, but we do not think that should give them an exclusive right. We think that others should have an equal right to use the streets. We contend that they are claiming an unfair advantage, because they happen to be first in discharging their return current into the streets. As to whether the Tramway Company would bear a share of the cost of perfecting the telephone system, I cannot say. I certainly think they should not be expected to do so.

14. *Mr. E. M. Smith.*] Are you satisfied with Dr. Lemon's report, or would you think it advisable to call an expert witness as to the cost to the department?—Yes; I think an outside expert should be called.

15. Your own evidence is perfectly clear, but I think the Committee would like to have some statement as to the cost to the department. Would you be prepared to offer some expert evidence on this point?—We would be glad, indeed, if it would be of any service, to send a man from Dunedin to give expert evidence before the Committee. As to what would be the cost of the change of system I cannot say. Dr. Lemon is in a position to know what the cost would be. I shall be very glad to send up an expert from Dunedin to give evidence if you wish it.

16. *Mr. Earnshaw.*] Of this number of tramways in America, how many are there which are in conflict with the telephone system?—I cannot answer the question. I have no information on the subject.

17. You have no reason to believe there is a large number?—No; I think not.

18. *Mr. Lake.*] A part of your argument applies to what you propose as well as to the telephone system as at present worked. If they use the earth, would not your system do exactly the same—so that you would establish on the public road a state of things similar to that which you object to?—It would not give us a monopoly of the earth. We would only have an equal right to its use with others—all we now ask.

19. But you would use the earth in the same way that they do. Therefore any argument against the telephone system as at present worked is equally applicable to what you propose?—No; because we say the Telephone Department has no exclusive right to the use of earth. If it has any right at all, we ought to have an equal right. It may be that it has no right whatever, as it has no specific permission from the Corporation to use the streets for its return current. This permission the Corporation had given to the Tramway Company.

TUESDAY, 1ST AUGUST, 1893.

A. I. SUCKLING-BARRON attended and gave evidence.

The Chairman: Will you state to the Committee what you know in reference to the subject of this petition?

Mr. Suckling-Barron: In 1892 I started from New Zealand and went through America, with the object of inquiring into the various electric tramway and electric railway systems there. I went on to London, and there saw the various lines and modes of construction. In Stockholm, in Sweden, I saw them changing the earth systems on their telephone-lines and putting in the metallic return. I also went to several other cities in Europe, and saw tramways working. In America I saw the very extensive system from San Francisco to San Jose, and at Salt Lake City saw the single-trolly system, and I actually worked one of the cars for a day or two. At Schenectady I saw Mr. Edison, and, in the course of a conversation, he explained that the single-trolly system was the only satisfactory system, and that out of 100 lines there were 92 per cent. worked by this means, the other 8 being on the double-trolly system. I have also the expert evidence given by Mr. Edison himself, when examined by Chief Justice John S. Wise, in the suit of Pelton *v.* the East Cleveland Street Railway Company, in which suit he was asked whether he had ever been engaged in the actual installation of electric railways within the past three years, and how many of such railways there were in existence in the United States. In reply he said he did not know, but supposed there were between two and three hundred. The actual number is 504, and at the present moment—or during last year—in the United States there are 6,853 miles of lines on the single-trolly system. Six thousand cars are used on these systems, and over a thousand million passengers travelled over these lines in one year. Mr. Edison was asked how many of these railways in America were of the kind known as the single-trolly system, and said that his impression was that 90 per cent. were on that system. The Judge said, "State how many systems of electric railways have been experimented with, and the advantages or disadvantages of each, briefly." He said there had been an enormous number of different systems advertised and experimented with in Europe, in England, and in America, but the only system which had proved commercial outside of the overhead-trolly system was one single case of the Siemens Electric Railway in the suburbs of Berlin. He was asked whether or not, "in your judgment, the single-trolly overhead-wire system is successful, and whether there is any other known system of which the same may be said." He said, "I do not know of any other system that is successful except the single-trolly system at the present time." Then he was examined again at his laboratory in Orange, New Jersey, by Chief Justice John S. Wise. He was asked, "When was the principle that the earth may be used as a return current for electricity discovered, and by whom?" He said, "Somewhere in 1835, by Steinheil, or Morse." He was asked whether the principle was patented by anybody, and he said that Morse attempted to patent it, but did not succeed. He was asked whether the earth has since been used by any and all electrical enterprises desiring to use it, and said, "Yes, it has been of universal use, except in some systems of electric lighting which have come up within the last few years." He was asked, "In your opinion, as an expert upon telephoning, is the grounded telephone the best system available to the telephone service, and, if so, why? and, if not, why?" He said, "No, the best circuit is the metallic-circuit method, not using the earth as a return. This prevents induction and interference of other wires, but is not universally used on account of the fact that the expense for wire is double, although it is used in Paris entirely." I may say that the whole of the system has been changed in Paris from the earth return to the metallic return. If you telephone a person in Paris, no matter what distance, there is no cross-talk whatever, and you hear quite clearly the conversation. In New York they commenced about a year ago to change the telephones from earth to metallic return, and are still engaged in doing so.

20. *Mr. Earnshaw.*] Will you explain the difference?—The earth return is this: A current of electricity can only flow in a closed circuit. A wire leads from the Exchange to each subscriber's instrument. If one person wishes to converse with another, he rings up the Exchange and is connected through. The current flows from the one subscriber's instrument through the Exchange to the other subscriber's instrument, and back by the return circuit to where it started from. In order to save a return wire, each instrument is connected on earth, and the earth is used as the return circuit. If a cablegram were sent from London to New Zealand the current would go by a single wire; the instruments would be earthed in London and New Zealand, and the return current would flow back through the earth. You can understand the enormous saving there is by this system for wire alone. A telephone is likely to be disturbed by leakage from electric circuits, light or power, or by thunderstorms. A metallic return would greatly obviate such disturbances.

21. Would that be from post to post?—Not necessarily. A good many telephones could be connected on to one wire as a common return, and then taken back to the Exchange.

22. So that it does not necessarily mean a metallic return to every telephone?—No.

23. *The Chairman.*] Would it matter what number you had of these single short wires on to a main one?—No; you can put on any number. Of course, if you had to run a great distance on to an earth-wire, it might pay to have a separate one for each instrument. In crowded streets a great number might be put on one return.

24. *Mr. Moore.*] What are the advantages of the double-trolly system over the single trolly?—There are very few. In the double-trolly system, in going round curves, there are great difficulties. In the double-trolly system you have to have two wires, and at curves there is a difficulty in keeping them apart; and unless the wires are run with equal sag, and the trolleys made good contact, there is apt to be excessive sparking. Of course, you have to use heavier poles, which have to be more heavily stayed, and the liability of lines coming down is greater. On a line where there are twenty or thirty cars running, if one were to lose contact a blockade would be probable.

25. *The Chairman.*] Is the double wire more expensive?—Yes, much, and not so efficient.

26. *Mr. Moore.*] If you had a single-trolly system would that mean taking charge of the whole street on account of the electricity being so powerful?—The effect would be on telephones; they are very delicate instruments, and their action depends on the vibration of a ferrotype diaphragm which is actuated by extremely small currents. Tramway or other electrical systems would take care of themselves.

27. But the telephones could make use of the earth?—Yes, under certain conditions. Electric lighting companies are debarred from using the earth-return when working above a certain electrical pressure. It would be absolutely dangerous for them to use the earth as a return when using a high electro-motive force, owing to the chance of a leakage on the one insulated wire, when contact with same might mean serious damage to persons. In the case of a tramway company, Mr. Edison recommends that not more than 500 volts should be used when earth is the return. Although there are these effects upon telephones, the single-trolly system is being used in hundreds of cases, and the rails used as return; each rail is joined to its neighbour by a copper strip about a foot long, with an eye at either end, and a copper rivet put through the eye and rail and well rivetted up. This is supposed to make a complete metallic circuit.

28. Is it possible to use the line as a return?—It is being used in America, and the public there is not up in arms against the single-trolly system.

29. *Mr. Earnshaw.*] Has there been any difficulty between the tram services and the telephone subscribers?—There have been difficulties, and they are to be got over by the telephone companies using a metallic return.

30. *The Chairman.*] Are the Committee to understand that if the single-trolly system were adopted, and the Telephone Department adopted the metallic return, neither would injure the other?—Certainly, that is the case. The induction caused by the use of the single-trolly system, when the telephone exchange is using the earth-return, can be fairly well got over by using the copper strip as described. But that copper strip must be rigidly inspected from time to time to see that contact with the rail is good.

31. *Mr. Earnshaw.*] I presume the Tramway Company in Dunedin would be quite prepared to put the copper strips on the line?—Yes. Tramway companies have not consented to its use on account of any pressure brought to bear on them, but simply for the protection of the telephones. In America, they have in several cases a bare wire running down the centre of the track, and every rail is joined across on to that wire. With that arrangement you of course get an even better return circuit.

32. *The Chairman.*] Could you give the Committee any information with regard to the extra cost involved in making the alteration to the telephone system?—Not unless I went over the ground. Circumstances alter cases so much. Mr. Edison was asked: "In your opinion, as an expert on telephoning, is the grounded telephone the best?" He said, "No, the telephone suffers more from its own self than anything else I know of. What is said on one wire, under certain conditions, is heard on half a dozen other wires. The metallic circuit obviates this, and prevents what they call 'cross-talk.'" He was asked whether the successful use of a grounded circuit on the telephone depended upon its having exclusive use of the ground; and he said, "Certainly not; if you make a good contact with the rails in the electric motor, it would not interfere particularly." I think that is the best evidence you can possibly get. The Judge said, "So long as anybody uses the earth, can a grounded telephone be successful?" and the reply was, "Certainly, if the rails were united as I say." He said, "If the telephone is to be made free from all sounds and all interference, then my impression is that the power and light stations would either have to stop, or else the telephone would have to employ metallic circuits." That is, you must stop all motors for domestic services, and so on. There was a very important decision given some little time ago. The National Telephone Company of England was the plaintiff, and Mr. Graff Baker representing the Leeds Tramway Company the defendant. The National Telephone Company wanted a permanent clause inserted by the Board of Trade in all Tramway Bills, in order to save the expense of opposing each Bill. At the present moment there is a Select Committee of the House of Commons and the House of Lords taking evidence, with a view to decide once and for all, whether the telephone companies are to have the exclusive use of the earth as a return.

33. *Mr. Moore.*] That would apply to the Government?—No, to any one. There was a case in the town of Halle, in Germany, a year ago. There the telephones are owned by the Government, which is semi-despotic, and it was thought very bold on the part of the Tramway Company to attempt a case with the Government. They did so, however; the case spread over several days, and was given by the Judge against the Government. The trams are running now on the single-trolly system.

34. *Mr. Earnshaw.*] If the Tramway Company took every precaution with regard to making their rails a good return current, would there be ordinarily as much conflict with the telephone system then as there is now?—There would be no more cross-talk heard in the telephones than there is now.

35. The percentage would not be great?—There should be a clause inserted in any Tramway Bill that the lines are to be properly inspected, and the return kept in proper order. In the case of The National Telephone Company *v.* Leeds Trams, in which case Sir Richard Webster, Q.C., Mr. Moulton, Q.C., and Mr. Bousfield were employed, Mr. Bousfield, in addressing his Lordship, Mr. Justice Kekewich, said he would only trouble him with one case—an important one—in which the British authorities were cited, and which plainly went on the same law as was administered in his Lordship's Court. It was The Cumberland Telephone and Telegraph Company *v.* The United Electric Railway (42 "Federal Reporter," p. 273). The concluding passage of judgment in this action ran as follows: "The substance of all cases we have met with in our examination of this question—and we have cited but a small fraction of them—is that, where a person is making lawful use of his own property, or of a public franchise, in such a manner as to occasion injury to another, the question of liability will depend upon the fact whether he has made use of the means which, in

the progress of science and improvement, have been shown by experience to be best; but he is not bound to experiment with recent experiment inventions not generally known, or to adopt expensive devices, when it lies in the power of the person injured to make use himself of an effective and inexpensive method of prevention. If, in the case under consideration, it were shown that the double trolly would obviate the injury to the complainant without exposing defendants or the public to any great inconvenience or a large expense, we think it would be their duty to make use of it, and should have no doubt of our power to aid the complainant by an injunction; but, as the proofs show that a more effectual and less objectionable and expensive remedy is open to the complainant, we think the obligation is upon the Telephone Company to adopt it, and that defendants are not bound to indemnify it; in other words, that the damage incidentally done to the complainant is not such as is justly chargeable to the defence. Unless we are to hold that the Telephone Company has a monopoly of the use of the earth, and of all the earth within the City of Nashville, for its feeble current, not only as against the defendants, but as against all forms of electrical energy which, in the progress of science and invention, may hereafter require its use, we do not see how this Bill can be maintained. We place our denial of an injunction on the grounds: Firstly, that the defendants are making lawful use of the franchise conferred on them by the State, in a manner contemplated by the statute, and that such act cannot be considered as a nuisance in itself. Secondly, that in the exercise of such franchise, no negligence has been shown, and no wanton or unnecessary disregard of the rights of the complainant. Thirdly, that the damages occasioned to the complainant are not the direct consequence of the construction of the defendant's roads, but are incidental damages resulting from their operation, and are not recoverable. The cases involving this principle are almost innumerable, and, in our examination of them, we are satisfied the great weight of authority bears in the direction we have indicated. As a result, the motion for an injunction must be denied." The learned counsel then commented on the cases quoted by Sir Richard Webster in his opening speech. "The defendant rested his case on the well-known case referred to of Vaughan *v.* The Taff Vale Railway Company. He submitted that the present case was almost identical with Vaughan *v.* The Taff Vale Railway Company. That was a case of what might be called dangerous employment of a dangerous article, a locomotive; and it was upon the ground that the statute had expressly authorised the use of a dangerous article, and that the dangers of the article were contemplated in authorising its use, that it was held at the result—namely, the spark setting fire to some of the property, was one contemplated, and one against which the defendant was protected. Assuming, of course, that the danger here from an electric railway in reference to the present case was a danger of simply disturbing somebody else's wires, that was the danger which the use of electricity involved. He submitted that, as the net result of the evidence, the plaintiffs had failed to discharge the burden which was upon them, of showing that his client had been guilty of any negligence in the adoption of the system actually adopted. If disturbance of the kind complained of was a nuisance, then a disturbance by a telegraph wire, either so long or so near as to affect, or even a telephone wire which was so close as to affect, would also be of the same character. Therefore the plaintiff's argument necessarily led to the result that any electrical disturbance which was so great as to make noises upon their telephone wires was a disturbance which was *per se* a nuisance, and which was actionable. On the other hand, what the defendants admitted was that these were disturbances which were necessarily incidental to every great city, to every place such as Leeds or London; and that, having regard to the quantity of telegraph, electric light, electric power, electric tramway wires, and so on, that were gradually being used for different purposes, electrical disturbances were things which were incidents in the present state of civilisation, even though they were not incidents ten years ago, when the telephone was established, and that they were disturbances which the telephone companies themselves could, and ought, and must, from the very nature of their business, protect themselves against. Supposing the plaintiffs were freeholders, and that he was a freeholder, and that between the lands there was a long boundary. On the boundary of his land he put up a telegraph wire of sufficient length; on the boundary of their land they put up a telephone wire, coming within the range of disturbance. Then they would be entitled, if Sir Richard Webster's law was good law, to complain of the use of the telegraph wire as a nuisance if there were electrical disturbances. His case was that these were disturbances which, in a crowded place and in cities, people who had a business depending on very delicate currents must necessarily contemplate, and that they could and ought to protect themselves against these disturbances from the very nature of their business, and from the nature of the requirements of mankind at large in regard to other electrical devices which were now coming into common use. If they looked at the New Telephone Company and the Post Office, they would see they acknowledged that it was an incident of their business, that they must protect themselves against the ordinary incidents of that business. All over the world, practically, other people were doing the same thing. In New York they were transforming the exchanges and abandoning earth-returns. In Stockholm, even, where there were 10,000 telephones, which was a great number for a place of that size, they were already transforming their exchanges. In other places, for instance in Paris, they had already transformed the exchange." That case was extended over six days, and was given against the Tramway Company, and these trams are now running successfully.

36. *Mr. Earnshaw.*] Is there a known case at the present time where the lines have been made on the return system where they have seriously interfered with the telephone services?—Yes, on account of the connections not being kept in proper order. In America, where heavy snowstorms are prevalent, more disturbances are likely on account of a difficulty of proper contact between the tram-wheels and rails.

37. You would not contemplate anything of that kind in a city like Dunedin; under ordinary conditions the circuit would be practically complete?—Yes. To show you that telephones are affected by other systems than the tramway system, Sir William Thomson in this very case cited an

instance where, in a tunnel near Glasgow, the train lighted on entering the tunnel and the lamps extinguished on the train leaving the tunnel, disturbances occurred in the telephones. The telephone wires were double-backed and earthed some distance from the distribution-wires, and the disturbances ceased. He also said that the telephone labours under this disadvantage: that it strives to destroy the most practical system of railway circuits and to continue a relatively poor system of telephone circuits. In the case of telephones, the only remedy is to produce the only insulation which is considered first-class, without consideration for the railways; and for the telephone companies to claim that they alone have a right to earth-return is to practically monopolise the whole of the earth. The Judge, in the case against the German Government, in the Arles action, ruled that the telephone posts and wires were not among the original and primary objects for which the streets were opened. The streets were opened to facilitate transportation, and the company had no right to the use of them.

38. *Mr. Moore.*] All these cases you have cited, I presume, apply to private companies, not to Governments?—Yes. In the case of the Halle Company, the German Government have the exclusive rights for all telegraph and telephone systems.

39. Do the English cases apply to private companies?—Yes. The English Government own telephones in many towns, but the majority are worked by the National Telephone Company. In Newcastle the Government uses metallic return, and the National Telephone Company earth return, and it is a general remark that the Government telephones are the better. Another important decision was given in The Cincinnati Inclined Plane Railway Company, plaintiff in error, against The City and Suburban Telegraph Association, defendant in error: "The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street railways are by law authorised to be constructed; and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the rights of the public in streets for the purpose of travel and transportation. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city, prior to the operation of an electric railway thereon, will not give the telephone company, in the use of the streets, a right paramount to the easement of the public to adopt and use the best and most improved mode of travel thereon; and if the operation of the street railway by electricity as the motive-power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of electro-motive power upon the street railway. Where a telephone company, under authority derived from the statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric circuit for the transmission of telephonic messages, uses the earth, or what is known as the 'ground circuit,' for a return current of electricity, and where an electric street railway afterward constructed upon the same streets is operated with the 'single trolly overhead-system'—so-called—of which the ground circuit is a constituent part, if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground circuit as a part of the telephone system." (Decided Tuesday, June 2nd, 1891.)

40. *Mr. Lake.*] Is that a Court case?—Yes; it is a Supreme Court case. It goes on: "It is claimed that in addition to this conduction or leakage disturbance the single-trolly electric railway introduces serious disturbances on telephone lines by induction, for the reason that such electric railways employ large wires to convey the current used for the propulsion of their cars, and this current is constantly and rapidly changing its strength; that these rapidly-changing currents in the electric railway wires induce disturbing currents in parallel telephone wires near which the electric railways have been built, and thus prevent a successful transmission of telephonic messages. These interferences with the telephone service may be obviated, it is stated, by the railway company giving up the single-trolly system with the ground circuit, and substituting the double-trolly system with its two trolly wires, two trolly wheels, and electric current passing from one wire through one trolly, through the motor, back through the other trolly to the other wire, and so back to the generator, without escaping to the earth. The grounded circuit, it is insisted, should be abandoned and surrendered to the sole use and service of the defendant in error. But it is admitted that other remedies of the telephone disturbances may be easily obtained by constructing the telephone with a complete metallic circuit, or by resort to what is known as the M'Cluer device, consisting of a single return-wire, to which a number of telephone wires are attached. It is immaterial on which party the expense of the change may fall the more heavily. It is a question of legal right. The telephone business was not among the probabilities when the streets of Cincinnati, now made use of by the Telegraph Association, were dedicated or condemned for the public use. The primary and dominant purpose of their establishment was to facilitate travel and transportation; they belong from side to side and end to end to the public, that the public may enjoy the right of travelling and transporting their goods over them. The telephone poles and wires and other appliances are not among the original and primary objects for which streets are opened, for they may be placed elsewhere than on the highways, and yet accomplish their purpose. As a general rule, an occupation of the street, otherwise than for travel and transportation, is presumptively inferior and subservient to the dominant easement of the public for highway purposes; for, if not so, the primary object of their dedication or appropriation might be largely defeated. And the fact that permission is granted to occupy the streets or highways for a purpose other than travel does not confer a prior and paramount right to occupy them to the exclusion of their use for travel in a mode different from what obtained when such permission was given. To those improved agencies, devised for the convenience and advantage of the community in general, the franchise of the telephone company to occupy the streets for carrying on its business must be secondary and subordinate. Whether all

who go upon the streets shall have the most convenient and expeditious passage and carriage of person and goods, has not been made dependent upon the manner in which the defendant in error has preferred to locate its poles, stretch its telephone wires, or form the electric circuit. The demand made upon the Telegraph Association is, not that the Railway Company shall so modify its existing electrical apparatus as not to interfere with the telephone service, but shall for ever abandon the use of an essential part of its electro-motive system, or be perpetually enjoined. In other words, the Association claims the exclusive use of the grounded circuit, inasmuch as the mechanism of the telephone is so complex, and the electric currents employed so delicate and sensitive, that they cannot be used without disturbance from the heavier currents employed by neighbouring electrical enterprises that operate with the grounded circuit." The Judge said, "In our opinion there has been no invasion of the rights of the Telegraph Association by the plaintiff in error, and that the Telegraph Association is not entitled to the relief prayed for in the petition. The judgment, therefore, of the Superior Court at general and special term must be reversed, and the original petition dismissed. Judgment accordingly."

41. *Mr. Earnshaw.*] If the Tramway Company were to connect their lines with the copper strips, and were also to connect with another wire between the lines—that is, to make a perfect return as they go on—and with the climatic conditions of Dunedin; would it be the fault of the telephone system if there was any conflict between the telephone wires?—Yes, it would be entirely the fault of the telephone system if the telephones were effected, in not using a metallic return.

42. *Mr. Moore.*] If you made use of the earth-return current in the way you said, the telephone system can be protected?—Mr. Edison said there would be no particular interference with the telephone system if proper connections were made with the rails: and the proof of that is that there are so many thousands of miles on the single-trolly system, where the telegraph and telephone systems, run side by side. If the disturbances were so great that the telephones could not be used, the public would be up in arms against the single-trolly system. But they are not. There are just one or two cases that have come to light.

43. *Mr. Earnshaw.*] Are any of the overhead railways in New York being run by electrical cars instead of by steam?—No, they are run by steam entirely. There is just a light girder viaduct down every street where the lines run. They had an underground system of electric rails for a few months, in New York, but on account of melting snow there was a great difficulty in keeping the centre contact free. The street railway statistics for 1892 are: For fifty cities, with a population practically of 7,000,000, a street car trackage of 2,428 miles; gross receipts from operation, 48,810,786 dollars; passengers carried, 997,813,484. There were 13,000 ordinary cars, 7,000 box-cars, and 4,680 open cars in operation.

44. What streets in New York do the electric tramways run on? There are none in any of the main streets in New York. In the suburbs there are 276 miles of electric railway.

45. What I want to know is, where do electric tramways run through main streets where telephone wires are used?—In Salt Lake City there are three separate tramways running, and a line runs through nearly every street.

46. Do they affect the telephone wires there?—Not that I am aware of.

47. You spoke of San Francisco and San José?—Yes.

48. Does the tramway run through San Francisco itself?—No, it does not run down the main street; but it runs through over one hundred miles of country after leaving the city.

49. Is there any place—any large centre—where there is any conflict between the telephone service and the tramway?—I think, yes; in Leeds, in England.

50. Some of the lines must go very close?—Yes. In Salt Lake City there is a tramway which runs through nearly every street.

51. *Mr. Moore.*] Mr. Edison stated that only one tramway company had been successful commercially. Does that apply to the double-trolly system?—Yes; he was asked to explain the different systems, and he did so. The Judge said: "Which, in your opinion, has proved a success commercially?" And he said: "The only system that has proved commercially successful outside of the overhead-trolly system is one single case of the Siemens Electric Railway, in the suburbs of Berlin." There is the Liverpool overhead railway in England, the Staffordshire tramway, the railway on Brighton beach, that at the Giant's Causeway in Ireland, one at Leeds, and there are several under construction that will probably be a success. And here, at Hobart, an electrical tramway is being put into operation.

52. Have those systems you referred to been successful, so far?—Yes, those in Staffordshire and Liverpool have been a great success. The trams have all been running five or six months, and they have been such a success that in Liverpool the capital of the company is being increased, and large extensions are to be made.

53. You stated that in America they have had in several instances the tramway companies and the telephone system working side by side successfully?—Yes.

54. Was the telephone system a complete circuit or making use of the earth?—New York is the only place I know of in America having the metallic return for the whole telephone service. It is just possible that in some cases, where the telephone companies have prosecuted the tramway companies and the decision has been given against the telephone companies, that the telephone companies have put up metallic returns.

55. Are there not some cases where the decision of the Supreme Court in favour of the tramway companies has been reversed by the Court of Appeal?—Not that I know of.

56. If so, will that not guide the Judges in future in reference to any powers the tramway companies may get?—Not necessarily; because we have the important case of the Leeds Tramway Company, which has been decided since in favour of the tramway company. There is The City and Suburban Telegraph Association *v.* The Cincinnati Inclined Plane Railway Company, in which the Judge said that "defendant was inflicting a legal injury upon the plaintiff, from which had already arisen loss, and which must inevitably cause loss in the future, constantly recurring. The order of

the Court would, therefore, be that the defendant be enjoined perpetually from the use of the system of electric railway propulsion as now operated by them, or any other which will occasion similar disturbances to those now caused by defendant's single-trolly system." Since that there are these other important decisions. A great deal of expert evidence was given in the case of the National Telephone Company against the Leeds Tramway Company.

57. *Mr. Lake.*] Supposing the Tramway Company's wish was granted, would it not be a fact that, owing to the higher tension of electricity they would use, they would practically have a monopoly over the streets so far as any further application for electricity with a lower tension was concerned?—Only in the case of a company using delicate instruments. Where the whole action of the instrument depends on the vibration of a ferrotype diaphragm, any current whatever discharged to the earth would be likely to affect it. But the fact of an electric light or power company supplying power to domestic motors discharging the current to the earth would not affect a tramway.

58. *Mr. Moore.*] Would it affect the electric light?—Not if the Electric Light Company had a proper insulated system, as it should have.

59. *Mr. Lake.*] The point I want to know is simply this: If you have a low tension of electricity, would it not affect a high tension of electricity?—If two wires are running parallel to one another, and the currents are running in opposite directions, then you are likely to get an induced effect.

60. Would any future application of electricity with a return-wire be affected injuriously by the Tramway Company if the electricity used was of a lower tension?—I do not know what effect it would have. There was a peculiar effect I might cite of the London Electric Supply Company, between London and Deptford. The company put 10,000 volts into their mains at Deptford, and they found that they got several hundred more volts at the London end, seven miles away, than they had at Deptford. The cable acted as a condenser.

61. Supposing you had another company running wires parallel to yours; if the tension was very much higher in yours, would that not induce a current in the other line which would be injurious to it? Take the case of two wires, a lead and a return, running out from one station with a current in both of them, and two wires running out from another station running side by side?—I do not think there would be any effect if the systems were insulated, because the fact of the return-wires running close together would probably cancel any effect.

62. If a tramway company was existing in a street and some other application of electricity was wanted, you would have no claim whatever?—No.

63. I see two of these cases have been decided against the tramway companies; and the express reason given is that there is another system which is in practical use and can be applied, and the Judges ruled in favour of the telephone company?—Is that lately?

64. One is the Cincinnati case and the other is at Albury.—The Cincinnati Railway Company I know lost their case in the first instance, and I believe the decision was reversed afterwards in their favour. I think you will find that in later cases, where expert evidence has been taken, that judgments have been in favour of the tramway companies.

65. Of course, the case is contemplated in New Zealand, where the Government have the rights under the Electric Lines Act?—Yes, I know the powers given by the Electric Lines Act are very great. It is quite possible for the Government—although the Bill in favour of the single-trolly system might pass through Parliament—for the Government to obtain an Order in Council and make the Act useless. But it is just the principle, whether the Government should monopolise the earth or not. Of course, the Government have the whip hand, and are not like a private company.

66. In giving evidence, you cited the case of the Halle Company against the German Government: Can you give the date of that?—I will get the date for you.

FRIDAY, 4TH AUGUST, 1893.

STATEMENT put in by Mr. J. H. HOSKING.

I have acted throughout as the solicitor in connection with the negotiations which have taken place; first, for the purpose of obtaining the consent of the city and town suburban boroughs interested, and next for the purpose of obtaining an Order in Council sanctioning the use of electricity as a motive-power for the trams. The immediate cause of my request to be heard by the Petitions Committee was that I had heard Dr. Lemon had cited before the Committee some American decisions, the purport of which, in his view, gave telephone companies who had occupied the streets before the electric trams paramount consideration in determining whether the trams should bear the cost of doing what might be necessary to save the telephones from prejudicial disturbance. I intend to deal with that aspect of the subject presently, but before doing so desire to point out how matters stand with regard to the Dunedin trams.

The Tramways Act of 1872 is the governing statute. That statute authorises trams to be constructed either by the local authorities themselves, or by companies who have obtained permission to do so from the local authorities. But in order that the body promoting the tramway may be able to exercise the compulsory powers given them—in other words, in order that the tramway may be a lawful establishment to all intents and purposes, an Order in Council must be obtained from the Governor. Before the Abolition Act it was the Superintendent of the Province who issued the order. (See section 9 of Tramways Act.) That Act then provides (section 9) that the order shall contain such provisions as, subject to the requirements of the Act, the Superintendent (now the Governor) according to the nature of the application [for the order], and the facts and circumstances of each case, thinks fit. The Act then enacts a number of provisions, contained in Parts II. and III. of the Act, which are of an enabling character, as for example to break up streets, &c., which are to be implied in every order unless provided to contrary. To this end the Act enacts that all or any

of these provisions may be expressly varied or excepted by the Order in Council (see section 22). It will therefore be seen that the Order in Council is a most flexible instrument, and may adapt or exclude the provisions of the Act or make new provisions, as the circumstances of each case may demand. Then, section 13 of the Act enables the Governor in Council to from time to time revoke, amend, extend, or vary an Order in Council by a further order. It remains to be noted that, by section 33 of the Act, all carriages used on any tram shall be moved by the power prescribed by the order, and, where no such power is prescribed, by animal power only.

The necessary consent of the City of Dunedin to the principal line was obtained in 1877, and the consents of the other boroughs followed in 1878, 1879, and 1880. Orders in Council were issued on the footing of those consents. The order prescribed as motive-power, animal-, or steam-power. Steam-power was used for some time, and ultimately abandoned for horse-power, by which all the cars are now moved.

It stands as an admitted fact that the tramways had pre-occupied the streets some years before the Telephone Exchange was established.

Then came the proposal to substitute electricity as the motive-power, horse-haulage being found to be too expensive. This proposal had been sanctioned by the City Council as far back as August, 1889, it having been brought before them on the 24th June previous. The Council then "agreed to give facilities to the company to carry out what is called the overhead system of electrical propulsion." It was not, however, till the end of 1892 that the company found itself in a position to finance the substitution of the new method.

On the 19th January last plans and specifications were forwarded to the Public Works Department that they might be gone into in anticipation of the preliminaries to obtaining the Order in Council being complied with. They were referred to the Engineer-in-Chief, who made certain inquiries and requisitions. Upon this, Mr. Hay, Civil Engineer, and Mr. Murray, representative of Siemens Brothers and Company, met the Engineer-in-Chief in Wellington, and his inquiries and requisitions were answered and satisfied. Meanwhile, on the 24th February, the Public Works Department wrote that "The Minister was advised that the existing Tramways Act was not intended to apply to electrical tramways, but merely to what were known as street tramways at the time the said Act was passed."

This proposition was combated both by correspondence with the Public Works Department, and by Mr. H. D. Bell and Sir R. Stout in personal interviews with the Solicitor-General. Then, the Public Works Department advised "the Act did not apply to the overhead system." Ultimately it was ascertained that it was the definition of the term "road" in section 2 which created the difficulty. That definition says, "road" shall mean any carriage-way being a public highway; and the Law Officers considered that meaning to exclude authority to erect the necessary posts for the overhead system on the footway. The Tramway Company contended that the municipalities had ample power to sanction the erection of the posts, and had done so. In the Leeds Tramway case, hereafter alluded to, the Attorney-General raised the same question for the Telephone Companies; but the Court ignored the objections and justified the tramways. The English Act and the New Zealand Act may, it may be mentioned, correspond in their provisions, the Board of Trade being in the English Act substituted for the Governor. However, to amend the Act, so as to meet the difficulty raised by the Law Officers, the Government promised to introduce an amending Bill this session. Shortly afterwards they asked my firm to draw the Bill, as the Law Officers were busy. This was done, and the Bill sent to the Government early last June. This Bill was drawn as a general Bill, and was not confined in its terms to the case of the company I represent. It contained a clause authorising the insertion in the Order in Council of provisions for guarding the public safety and interference with electric lines. These provisions would, of course, be available in any case where the company was willing to submit to them, but cannot be said to prevent a company from arguing against the equity of any provision sought to be imposed on it. It was not till after this Bill was drawn and sent in—viz., not until the 26th June, that my firm was informed of the requirements of the Telephone Department.

I. Summarising the foregoing, these points are to be noted:—

(1.) That the company's tramways had preoccupied the streets some years before the establishment of the Telephone Exchange.

(2.) That the Tramways Act extends to the authorisation of the overhead system; but that doubts are raised by the Law Officers whether the Act would authorise the erection of posts and wires as required by the overhead system.

(3.) That the object of the proposed Bill is to remove these doubts.

(4.) That the question of what conditions are to be imposed on the Tramway Company will still remain to be worked out in obtaining the Order in Council.

(5.) That the tramway company have a grievance, in that the objecton on the part of the Telephone Company was started on them so late.

It is to get a pronouncement, either by a resolution of the House, or by an addition to the Bill, that the company is not, by any Order in Council that may be issued, to have imposed on it as a condition the adoption of the double-trolly system, or the payment of the cost of making a metallic return-circuit for the telephones, that the petition is presented.

The contentions for the company against the double-trolly system are these:—

(1.) That the evidence is all one way as to the superiority of the single-trolly system proposed by the company.

(*a.*) The evidence of Mr. Baron, of the Gülcher Light Company, is entitled to great weight, as he has made himself conversant with the systems prevailing in Europe and America. This gentleman gave evidence more out of enthusiasm for the cause of science than at the instance of the company. I did not know what evidence he would give. I only learnt from him afterwards what his points were. His evidence is, I respectfully submit, of more value, as that of a general elec-

trician, than is evidence furnished from the antipathetic standpoint of those interested solely in telephones.

(*b.*) The evidence in favour of the single-trolly system is explained by the fact that it is the system most generally used. The evidence and authorities given by Mr. Baron conclusively prove this.

(*c.*) The double-trolly system is not so well adapted to steep grades, as exist in Dunedin, or for turning corners, as the single-wire system; as the double trolly more easily gets out of gear, with the result that, if it does so in one part of the line, all the cars all over the line have to come to a standstill.

(*d.*) I would here quote from Crosby and Bell's book, pages 142 to 144 :—

"Except in the matter of the rail-and-earth circuit, all that has thus far been said applies equally well to the single- and double-trolly systems. The latter has now been almost wholly superseded by the former. There are three reasons for the survival of the single-trolly method as the fittest: First, greater simplicity of overhead turn-outs and frogs, in so far as the mechanical operation of the trolly is concerned—and this is the controlling reason; second, greater facility in insulating the out-going from the in-going side of the circuit, for, when the rail-return is used, these sides are about 18ft. apart, while with the double-trolly wire they are from 8in. to 18in. apart; third, greater economy of copper in large systems. This advantage is not as great as has appeared from the comparisons already given in discussing the copper calculations. An offset must be made by considering the cost of bonding the rails thoroughly, as compared with the cost of supplying and erecting the copper return, which would serve instead of the rails and earth. In case of very light service, the first cost may be less for the double- than for the single-trolly system. A fourth advantage is usually claimed, in that fewer wires are actually required to be erected, thus diminishing the objections made to the whole trolly system merely on the score of 'looks.' To this, the advocates of the double-trolly (for there are a few) answer that in either system all feeder wires may be buried; that the comparison would then rest as between bare wires alone; that the single-trolly wire requires one or two guard-wires, stretched parallel to each 'live' wire, and these guard-wires require span-wires for their support—this being done to prevent foreign wires from falling across the 'live' wire and to the ground, where they may or may not make such contact as will cause them to be entirely burned out; that the double-trolly system does not require guard-wires, since, in case of any foreign wire crossing the two 'live' wires, it would be at once destroyed, and the trouble at the railway-station would end.

"There has been so little extension of this double-trolly system that it cannot now be stated whether or not the public authorities would generally allow this difference of construction as between the two systems. It does not seem probable. In Cincinnati, Ohio, where the Cincinnati Street Railway Company has produced the most notable example of double-trolly service, guard-wires were however not erected.

"The advantages of the double-trolly system are two: First, it causes little interference with the telephone circuits that use ground returns in the neighbourhood of the railway lines. This has been the cause of much litigation, urged by the telephone interests, endeavouring to force the use of that system of electric railways which would least interfere with the established telephone service. Thus far, the Courts have ruled, for the most part, against such requirements.

"The case of the telephone labours under this disadvantage: that it strives to destroy the most practical system of railway circuits in order to continue a relatively poor system of telephone circuits. The remedy for the evils brought upon the telephone service by the disturbing earth-currents of the railway service is to be found in the use of complete metallic circuits for the one or the other or both. To apply the remedy to the telephone circuits is to produce the only installation which may be called first-class, with or without consideration of railways. The currents required for telephones are exceedingly small; the forces by which they may be disturbed are correspondingly small. To insist that, when passing through the earth, these currents shall not be perceptibly disturbed by other currents, is to insist upon a practical monopoly of the earth as part of an electric circuit. The best English and European telephone practice, uninfluenced by any trouble from railway currents, tends decidedly towards complete metallic circuits. To apply, on the other hand, the same remedy to the railways, is to impose serious difficulties in the way of the practical success of the operation of cars over the complexities of switches, turn-outs, cross-overs, and the like.

"We cannot do better, in setting forth more fully the merits of this controversy, than to give the opinion of the Superior Court of Cincinnati, and the Supreme Court in the State of Ohio. These are found in Appendix E.

"The second advantage to be noted is this: that effective insulation of the motor-windings may be more readily secured than in the case of rail-return circuit. In the earlier stages of the art this was indeed an important advantage, for on the single-trolly roads no accident was more common than the 'grounding' of armature of field-coils. Previous practice in winding for comparatively high potentials had rarely to deal with the case in which the metal of the machine was in fact part of the circuit. To produce a short circuit through the body of the dynamo it was generally necessary that the insulation of the wires should break in at least two points of different potential. When, however, one brush of the motor was connected, as was often the case, directly to the motor-frame (this latter being hung on the axle, whence the current passed through the wheels), it needed a break at but a single point to cause trouble. In the violent fluctuations of current-strength and magnetic density incident to car-service there were often produced very high electro-motive forces of induction, and these, if not the normal pressure of 500 volts, often destroyed the insulation of armature or field. In some designs this trouble has been practically met by attempting to insulate the frame of the motor from the car-truck. This will be seen to impose considerable mechanical difficulty. Generally, so much improvement has been made in the details of armature and field-winding that the matter has ceased to be big with misfortune, as was once the case.

"There are now in the United States not more than ten double-trolly lines, only one of which—that at Cincinnati—is of what may be called a modern construction—that is, built within the last two years. Of single-trolly lines there are several hundreds."

II. Not only does the evidence as to the merits of the single-trolly system tell for the company, but in this particular case the company will be unable to adopt the double-trolly system.

(*a.*) All its arangements for contract and cost have been based on the single-trolly system.

(*b.*) The Councils of the city and suburban boroughs, more particularly the former, have gone into the question and have given their sanction to the single-trolly system.

(*c.*) The great delay that must ensue if all the preliminary work has to be gone over again will probably be fatal to any fresh arrangements with the intended contractors.

(*d.*) The increased cost will not be within the compass of the company's resources.

III. Consideration ought to be given to the fact that four months elapsed after the subject was brought before the Public Works Department before the company were apprised of the telephone objections, and that, too, after the Public Works Department had made its requisitions without referring to the objections.

For these reasons we say the double-trolly system ought not to be forced on the company, but, on the contrary, it should be enabled to carry out its arrangements for the single-trolly system.

It is said that the Telephone Department is of more importance than the trams: permit me to point out that the telephones are not, like the telegraph or cable, a colonial or national matter. The telephones are a local affair. They are no more colonial than the trams. It is a question, therefore, of one local convenience against another—and both ostensibly profit-making conveniences. To give an idea of the local convenience of the trams, there are fifteen miles and a quarter of way belonging to this company in Dunedin and suburbs. For the year ending 30th November, 1892, 2,722,073 passengers travelled on them, at the fare of 1·62d. per passage. For the year ending 30th November, 1891, 3,388,489 travelled, at a fare of 1·46d. per passage. Further, it is the very people who enjoy the telephone system that seek to have electricity employed on the trams.

Then, it is said this is a private company that is applying. It is, but not a private company that pays. But it must be borne in mind it is a municipal convenience, and one which municipalities may themselves undertake if they choose. Owing, however, to the interconnection of one municipality with another, it has been found idle for each body to have a separate system of its own, so that the only effective way of affording cheap travel to their inhabitants is for various contiguous local bodies to hand over their powers to a third hand willing to undertake the duty. A tram company serving several local bodies, therefore, as this does, especially stands on a footing of public consideration, although undertaken by a company, quite as much as if a local body were itself working the system for profit.

Further, this company pays in rent for the use of the streets £426 13s. 4d. per annum, and bears the cost of repairing 15ft. of the width of the streets. The Telephone Department, be it noted, pays nothing. In addition to this, the company's concessions from the municipalities are for limited periods only, at the end of each of which the local body may step in and purchase the trams at a valuation. The local bodies, therefore, have considered themselves as having a direct interest in the trams, and are, practically speaking, entitled to them in reversion.

I therefore submit the matter must be regarded from a higher standpoint than that of a mere private concern. It must be treated as entitled to consideration on public grounds.

I have now pointed out that the evidence is in favour of the superiority of the single-trolly system—that there are special and weighty reasons why the double-trolly system cannot be adopted by this company, and why this company is entitled to consideration in not having that system forced upon it at the last moment, and why also the matter, though agitated by a company, should be viewed as a matter of public concern.

The alternative to the double-trolly system is, that the company should bear the whole, or, at all events, a portion of the cost of safeguarding the telephone-lines by setting up a metallic return circuit. It will, I think, go without saying that, if extra money is to be expended, it would go into the latter direction if used to perfect the telephone system, rather than to establish a double-trolly system and leave the telephone system in the present defective condition. I take it, therefore, that the cost of giving the telephone system a metallic return circuit is the point on which the question will be dealt with. To come, then, to the crux of the matter, the position is that the Telephone Department say to the company: If you do not adopt the double-trolly system you must take the alternative, and bear the cost of enabling us to equip our lines with a metallic return circuit. This cost is stated by Dr. Lemon to be £12,000, without adopting the McCluer device, which would be cheaper. The company's reply to that is, that the Telephone Department ought to bear that cost, and the whole of it. If this contention could prevail, then the Order in Council might issue containing all proper provisions safeguarding the telephone lines from negligent or careless conduct on the part of the Tram Company. That the Telephone Department is wrong in its position, and ought itself to bear the cost of the metallic return, I submit follows from the following reasons:—

(1.) The telephone system, in using the earth instead of a wire as a return circuit, is defective. The evidence clearly shows that, and Dr. Lemon admits it. This defect is the cause of the buzz and cross-talk now so frequently met with, and is one that will increase as the Exchange extends and its wires multiply. Exchanges in other parts of the world are, by the evidence, shown to be adopting the metallic return to insure efficiency, irrespective of electric trams. A recent prospectus of a telephonic exchange for the City of Norwich, published in the *Electrician*, makes a point, as an inducement to subscribers, that it "guarantees a complete metallic circuit." I refer to Mr. Baron's evidence as showing that the metallic circuit is being adopted by telephone companies for the sake of the greater efficiency. Will, then, the local Telephone Exchange for ever adhere to its present system, notwithstanding defects that are removable, and that in other parts of the world are being removed? I submit it will rather keep pace with the times, and itself introduce the changes the cost of which it now asks the company to bear?

(2.) If the Telephone Department must in time adopt the metallic circuit, all tram companies who thereafter adopt electricity as a motive-power will get off scot free of the expense now sought to be imposed on this company because it is first in the field, in advance of the time when the Telegraph Department would have no ground for objections. Why should this company be saddled with an expense that other companies will not be asked to bear?

(3.) As the primary and paramount object of streets is travel and transportation, improvements facilitating that object ought to have first and paramount consideration. This is a view I strongly urge. As if in anticipation of this very question, the Appeal Court, in the Cincinnati Inclined-plane Company *v.* City and Suburban Telegraph Association, reported page 353, "Crosby and Bell's Electric Railway," used language which I venture to say applies absolutely.

"1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street-railways are by law authorised to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the rights of the public in the streets for the purpose of travel and transportation.

"2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone-poles and -wires upon the streets of a city prior to the operation of an electric-railway thereon, will not give the telephone company in the use of the streets a right paramount to the easement of the public to adopt and use the best and most approved mode of travelling thereon and if the operation of the street-railway by electricity as the motive-power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the conditions created by the introduction of electro-motive power upon the street-railway.

"3 Where a telephone company, under authority derived from the statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric circuit for the transmission of telephonic messages uses the earth, or what is known as the 'ground-circuit,' for a return current of electricity, and where an electric street-railway afterwards constructed upon the same streets is operated with the 'single-trolly overhead system,' so-called, of which the ground-circuit is a constituent part, if the use of the ground-circuit in the operation of the street-railway interferes with telephone communication, the telephone company as against the street-railway will not have a vested interest and exclusive right in and to the use of the ground-circuit as a part of the telephone system. (Decided, Tuesday, 2nd June, 1891.)

"In Taggart *v.* Street Railway Company, 16 R.I., it was said by Durfee, C.J., that telephone-poles and -wires are not used to facilitate the use of the streets for travel and transportation whereas the poles and wires of the railway company are directly ancillary to the use of the streets as such, in that they communicate the power by which the street-cars are propelled.' As a general rule, an occupation of the streets, otherwise than for travel and transportation, is presumptively inferior and subservient to the dominant easement of the public for highway purposes, for, if not so, the primary object of their dedication or appropriation might be largely defeated. And the fact that permission is granted to occupy the streets or highways for a purpose other than travel does not confer a prior and paramount right to occupy them to the exclusion of their use for travel in a mode different from what obtained when such permission was given." [See Appendix E for full report of judgment.]

But it is said "The Electric Lines Act, 1884," gives the Telegraph Department a paramount right. I say in answer that that Act gives no right to the department to use the earth as a return circuit. It gives a right to maintain its posts and wires in streets, but not the right in question. Nor, I submit, had the local bodies power to surrender such a right, and thereby possibly for ever preclude themselves from using electricity as a street-motor. The trams were in operation in the streets years before the telephone. They were there with the Tram Act in existence enabling the company to obtain a variation of its Order in Council and substitute electricity at the time the telephones were constructed. With this latent power in the company with regard to its trams at the time the telephones were put up, who ought to stand in the way if the company now seeks to put forth that power?

The English law in the Leeds Tramway case, I submit, clearly shows this: that if the Order in Council were issued to the Tramway Company, and the Telephone Department then brought an action to restrain the Tramway Company from affecting the telephones, the Telephone Department would not succeed. That case clearly shows that, because the tramway company, which was one that used the single-wire system, did not choose to take precautions to safeguard the telephones which were there before it, it was not bound to do so so long as its own system was a good one and it was worked carefully and without negligence.

The American authorities that I have been able to find bear out the same view. The case on appeal of the Cincinnati trams decided in Ohio, and already cited, is particularly strong. And here I would point out that Dr. Lemon is wrong in assuming the judgment in error at page 353 of Crosby and Bell's book was overruled by the judgment of Taft, J., at page 358. The very opposite is the case. The judgment of Taft was that of the superior Court of the State. The judgment on Appeal I take to be the judgment of the Supreme Court of the United States.

I have searched for a report of the Waterfleet Company case, cited by Dr. Lemon, but cannot find it. It was decided in June, 1890, whereas the Cincinnati judgment was delivered in January, 1891.

I have, however, found another American case—one referred to in the United States Digest of 1890, at page 1951, as follows:—

"A telephone company cannot maintain a Bill to enjoin the operation of a subsequently constructed electric railway to prevent the disturbance of plaintiffs' business occasioned by the escape of electricity from defendants' rails, which is an incidental result of the operation of the

road, where the evidence tends to show that plaintiff may obviate the disturbance by the use of a single return-wire on each route disturbed by the railway service to which each telephone is connected, and which operates to complete the metallic circuit, and that such device is simpler and less expensive than any the railway could adopt to effect the same end. (Cumberland Telephone and Telegraph Company *v.* United Electric Railway: 42, "Federal Reporter," 273.)

I would now refer to an extract from a number of "Practical Engineering," a standard work, published three or four months ago. This is not a work devoted to one branch of mechanical science more than to another. It is a sort of encyclopædia:—

"... The kind of overhead conductors now most widely used are ordinary round wires. They have been applied in America, both with double and single conductors, with great success. In some American cities laws have been passed prohibiting earth-returns, and the tramway companies have been compelled to put up double conductors. This, of course, much increases the cost of the line, and entails many additional difficulties, chief amongst which is the construction of shunting-switches for passing the cars on to different lines. It is also necessary that the contact-device or trolly should touch both wires at the same time, and great care is required in putting up the conductors.

"At the Roundhay electric tramway, at Leeds, which is an example of the latest and best American practice, one overhead wire is used, and there is now a open war between them and the telephone company, who object to the earth being used as a return, because it interferes with their telephone service.

"A similar contest took place at Halle, in Germany, where a small tramway, running about twenty cars, was put into operation a year ago, with overhead conductors and an earth-return. In Germany the telephones, as well as the telegraphs, are in the hands of the Government; and, directly the tramway company began running, it was stated that they interfered with the proper working of the telephone and telegraph services, and the case came before the law-courts. It is a very curious thing that in a semi-despotic country like Germany a private company should determine to fight the Government. But they did do so, and, what is more, they won the day. ..."

These authorities, I submit, clearly show that street-travel is the paramount consideration, and that telephone companies can assert no exclusive right to the use of the streets as a return circuit because they have preoccupied them in advance of the trams, and that, as the single-trolly system is the best, and involves the use of the streets as a return circuit, none has a higher right to that use than the trams, which are designed to facilitate street-travel and transportation.

The question then comes down to this: Is the Government, because it has a defective telephone system—a local profit-making concern—within certain municipalities, to exclude those municipalities from using electric trams—also a local profit-making concern, but likewise of a public character—to exclude them from using their streets for facilitating the very purposes of streets, unless the tramways pay the cost of doing now what the Government will ultimately have to do at its own expense—namely, make perfect its present imperfect system? That is what the proposals of the Telephone Department amount to. In other words, it seeks to do what a private company, acting under the Electric Lines Act (and there may be cases of that kind—see Section 14) would not have the least foundation for doing. In other words, the Telephone Department ask as the price of its sanction to the Order in Council the cost of giving it a good in place of a defective exchange, and to the benefit of—whom? Clearly, of itself, because the secrecy and efficiency otherwise of the telephone will be enhanced, and its extension will be more practicable. Such a position on the part of a telephone company would, I submit, for the reasons given, and on the authority of the law cases cited, be wholly untenable. Why should the Government which fills the place of the private company be in a different position?

The whole trouble arises from the fact that the agreements with the local bodies have to be ratified by an Order in Council. Suppose those local bodies could have granted the right asked for, and the Telephone Department had then attempted to stop the trams. All the cases cited show that the Telephone Department must put itself right, and must make its system self-contained at its own expense. Was it intended that the Government, because it institutes a commercial department, by establishing local profit-making conveniences subordinate to the primary use of streets, should withhold its consent to a tramway system, or to an improved motive-power thereon, because thereby such local convenience might be prejudiced? I submit that the Governor's consent should be granted irrespective of such a consideration, and that the question should be considered as it would be if it were a private company, or some local body, that worked the telephones. Brought down to that point, I submit the position is clear that the tramways ought not to bear any of the cost of putting the telephone system right.

Mr. J. H. Hosking, Dunedin, to the Chairman, A to L Petitions Committee.

Sir,— Exchange Chambers, Dunedin, 23rd August, 1893.

Re *Dunedin City and Suburban Tramways Company's Petition.*

I desire, with your permission, to supplement the statements I made before the Committee by adding that the Leeds Tramway case—that is, the National Telephone Company *v.* Baker—is now reported in the authorised Law Reports—viz., in the number for June, 1893, of the Chancery Division of the English Law Reports, p. 186. This case contains a reference to the Watervliet case, mentioned by Dr. Lemon. It is a case called "The Hudson River Telephone Company *v.* Watervliet Turnpike and Railroad Company." This case was cited by the Attorney-General as an authority in favour of the telephone company; but on his doing so it was pointed out that in that

case there was a subsequent decision of the Court of Appeal, dated 11th October, 1892, in favour of the tramway company. (See p. 198, June number of Law Reports referred to.) This disposes of the only remaining authority cited in favour of the Telephone Department's contentions.

I was unable to make this statement when I appeared before the Committee, as the June number of the Law Reports has only come from England since that date.

The Chairman, A to L Petitions Committee, House of Representatives, Wellington.

I have, &c.,
J. H. Hosking.

Friday, 25th August, 1893.

Dr. Lemon examined.

The Chairman: We understand, Dr. Lemon, that you will be able to give us some information in reference to the subject of this petition?

Witness: As far as the Department (Telegraph and Telephone) is concerned I can. I do not suppose any of you gentlemen have seen the report of Lord Kelvin's evidence before the Committee of the House of Commons and House of Lords on this question. It is contained in the *Electrical Review* for June 23rd, 1893. In that evidence Lord Kelvin, examined by Mr. Pember, said: "The escaping currents from electric-light lines affected telephones perceptibly at a distance of five miles, and considerably at many hundreds of yards. He had examined the Blackpool Tramway very carefully, and the generating station. The return circuit was through the wheels and by the rails. The potential was 300 volts, and there was very great disturbance. It was almost impossible to speak over the telephones at certain times during the running of the trams. He attributed it partly to induction. Two or three trollies instead of one would diminish the disturbance very much, and probably something in the way of brush contact would have the same effect; but the best method of preventing the disturbance would be a properly insulated return-wire. There would be no practical difficulty in laying this, whether the wires were overhead or underground. Two insulated conductors would allow a much higher working electric pressure to be used, and would diminish very much the quantity of metal used in the conductors. Accumulators were to be preferred in some respects; but there was the difficulty of weight, and expense, and no one could say whether they would or would not be used in the future. It would be a very great evil to the public if the number of overhead wires were doubled. If the tramway used the earth for the return circuit, it would be rendered unavailable to every one else." He did not think the use of the earth by the telephone companies should be interfered with, it was so valuable. The public required protection to prevent the gas- and water-pipes being utilised for powerful currents, such as those of the electric-lighting companies. He thought there was a prospect of accumulators. The cost was too great at present, but he thought it worthy of consideration. [Photographs showing the effects of electricity on water- and gas-pipes were put in by witness.] The evidence taken before the Committee of the House of Commons does not go into the effects of wandering currents upon telephones underground. That matter was not before the Committee then; in fact, it has only cropped up since 1st July, 1893. Before this inquiry was started, each time that an electric tramway company started they found that it would be an interference with the telephone system, and they had to fight out each case by itself. After about fifty cases had been heard, some of which had been decided in favour of the tramway companies and others in favor of the telephone companies, the matter was taken to the Board of Trade, and they were asked to do something to define the position once for all. The Board of Trade would not take it upon their shoulders, but referred the matter to the House of Commons. The whole of the evidence taken before the Committee, and also the summing up of the lawyers, is contained in the journals I have handed in. The decision of the Committee has not arrived here yet. I could have telegraphed to London for information, but I could only have got a few words of reply back, which would not be satisfactory. A mail is due in Auckland to-morrow, and will doubtless bring news of the report of the Committee. I have no interest in the matter under your consideration, save the protecting of the public property. The proposed electric tramway system will interfere with our telephone system to a large extent.

1. *Mr. Earnshaw.*] You will look upon the decision of the House of Commons as a final decision?—No; I do not think so. They have not seen this paper (*Western Electrician*, 1st July, 1893). It puts another phase on the thing. In the report of the evidence before the joint Houses, there is evidence by one Mr. Langdon. He pooh-poohs the idea of electric action of currents on wires underground, and on water- and gas-pipes. I shall be most happy to let you have the Committee's report, if I get it in time. I think it would be better to postpone coming to a decision on this question until you see what decision the House of Lords and House of Commons have come to. Since these papers from which I have quoted have come out, I have received a paper containing the report of Professor Barrett, Electrician to the Corporation of Chicago, on the effects of wandering electric currents on water- and gas-pipes. It shows conclusively the destructive action of the wandering currents from the electric tram-service on the water- and gas-pipes in that city. I do not believe the London people had that report in their possession before I had. There is no doubt that, apart from interference, wandering currents will have a destructive action on underground cables. Some of the cables in Chicago, which had only been down four months, were destroyed. [Dr. Lemon here produced photographs of single-trolly and double-trolly tramways.]

2. Do I understand, with regard to this destroying of electrical cables, that the electricity that is discharged from the tram-service permanently remains in the ground?—No. That has never been made clear to you, and I will explain it. Say, you have a battery (there is a great misunderstanding as regards the terms "positive" and "negative"): the copper pole inside the battery is called the "negative," and the zinc pole the "positive." The electricity deposited on the copper by the chemical action on the zinc, when it reaches the copper pole, and when it is discharged

outside the battery, becomes the "positive" and the zinc the "negative." Immediately the current goes out, the copper becomes positive. The flow of electricity is always in the one direction—from the positive to the negative outside the battery. The tramway companies use the positive pole of the dynamo on the line (the trolly-wire). They keep that line continually charged, and the other pole of the dynamo is connected to the earth—that is the single-trolly system. The electric current travels along the line (the trolly-wire), and, after it has done its work, passing through the motor, is discharged into the earth. The property of an electric current is to come back to its opposite pole by as many metallic paths as possible. The cause of the effects shown in the pictures I have produced is this: When the current leaves one metallic conductor for another it causes a sparking at that point, which in time dissipates the metal (eats it away). The current, in its flow, after leaving the motor, lays hold of all metal within its reach to arrive at its negative pole. Of that there is no doubt.

3. *The Chairman.*] I am not quite clear as to whether you mean the electricity would leave one line and become connected with another twenty chains away?—Yes; it would do so in the inverse ratio to the resistance offered to its path.

4. You mentioned that the current left its own line if it met with something better?—Yes; that is so.

5. Supposing it travels on this new conductor, and that was only half a mile long, would it return back to its own line?—It would get on to any metallic conductor in its path that would lead it back to its negative pole again through the earth.

6. *Mr. Earnshaw.*] With regard to the current attracting all metal in its path: If the electricity goes on to the car wheels, and from them to the rails, that rail being in thorough order and in connection with the line to the central station; assuming that there is another cable also in connection, is it not reasonable to assume that will take all the electricity from the machine?—No, it will not confine itself to the tram rails or to the cable unless they are insulated. If they are in connection with the earth, the electricity will distribute itself in the inverse ratio to the resistance offered.

7. *Mr. Swan.*] What is being meant by the "inverse ratio"?—It is this: Say you have five conductors, each succeeding one twice as good as the former as regards its metallic conductivity: The electricity will divide itself and take hold of the whole lot of them and travel along them, the quantity of electricity on each conductor being in proportion to the respective conductivity of each conductor.

8. *Mr. Lake.*] They use the term, "discharge of electricity." Is there any such thing as discharge of electricity?—Yes; there is such a thing.

9. *The Chairman.*] Does depth in the earth make any differenee to the cables?—No difference at all, within certain limits, so long as there is anything like moisture between them.

10. *Mr. Swan.*] Have any trials ever been made, to know whether any current has been set up on water- and gas-pipes of their own, as independent from the introduced current which has been proved to exist?—Not with two similar metals; copper and iron would. Cast- and wrought-iron would not make a current.

11. Is there no possibility of another current?—No. As regards the latest remedy, by joining the rails with strips it becomes a good conductor so long as they are kept in good order. Copper and iron hate one another. Where the rails are on sleepers the very jarring weakens the rivetting, and space is created between the copper and iron. Into this space the water gets, and an electric action is set up, and day by day it gets worse. This is the weak point, and they are continually finding it out in America. I have not gone into the question of traction very much; telephony and telegraphy are my special spheres. I am, however, quite certain that the process of using a single trolly is a very wasteful one. Looking at it from any view you may, you come back to the one conclusion, "That by the one-trolley system, a large amount of energy, which costs money to produce, is thrown away."

12. *Mr. Lake.*] A certain part of the energy used for the purpose of the tramway would be lost in setting up the action?—The current generated in any system is governed by the electric motive force divided by the resistance, which also includes the back electro-motive force of the moter. Take the friction of water in a tube. The quantity of water delivered in unit time is governed by the pressure and the frictional resistance of the tube. Now, in regard to the tram-cars, the mere fact of the wheels rolling round—being the only means of connection with the ground system—it is known that the wheels do offer resistance to the current passing from the axles to the wheels on to the rails. I have calculated that they must lose quite 30 per cent. of their energy at times through the fact of the continuity of the metallic conductors not being perfect. [In a Journal to hand since this evidence was given, it is put down at 33⅓ per cent. loss.]

13. *Mr. Swan.*] Does that apply to the double as well as the single-trolly lines?—No. The double is insulated. The current goes right back again. It only loses the energy which it has to exert in overcoming the resistance of the conductor—which, if you make it large, becomes little or nothing. You get the whole of the energy generated for useful work, minus what is lost in resistance.

14. *Mr. Lake.*] As I understand the claim of the Government, it is that they have a vested right in the earth-return for their discharge of electricity from the telephones?—We have been in undisturbed possession of this earth-return for the last sixty years. In a portion of Mr. Baron's evidence, I notice that he said that Edison attributed the discovery of the principle of the earth-return to Steinheil or Morse, in 1835. Now, I may tell you that when the telegraph system was first inaugurated they used a return-wire. In 1837, a man named Steinheil discovered—or rather re-discovered, I should say—that they could do away with the return-wire and use the earth instead. It has been the common acceptance that Steinheil discovered it; but in volume 9 of the "Transactions of the Royal Society," page 490, it is shown that the discovery of the earth-return was made by William Watson and others in the year 1747.

15. You are setting up a claim for the Government similar to that set up by the telephone companies in England and America, and that claim seems to be decided by the last decision in England at Leeds?—That decision at Leeds was practically no decision. The Judge said he had no power to decide the case. It was not lost on its merits. [See Appendix A.]

16. He said that the Telephone and Tramway Company were each acting in accordance with their statutory rights, and the fact that the Tramway Company interfered with the Telephone Company did not warrant him in giving a decision against the Tramway Company?—The Judge had no constitutional right to decide on that case, and he had to dismiss the action. He had no law to guide him.

17. We have no law here. What right has the Government, excepting their prior occupation, to a monopoly of the earth circuit?—That opens up another question altogether.

18. The Government telephones in England have all the earth circuit, and the evidence shows you that they are not subject to interference?—Such is not the case. The telephone companies with the single wires are taking all the business away from them. The public are going to the telephone companies and leaving the Government in some places. I belong to a private telephone association in America. They have conducted a number of experiments with telephone cables, and it is a positive fact that, unless you follow with the same pair of twin wires in a system of underground cables, for instance, the two wires in the core of the first cable must be joined to the two same wires encased in the next junction cable, otherwise induction is set up at once. If you have two wires running side by side, and, through a mistake or carelessness, the two outside wires are joined in the next cable, the effect of non-interference is partially destroyed. The two wires of the one cable must, in their relative positions, be kept together throughout all the cables, otherwise you will get induction in these two wires by their being apart from each other. This has been proved beyond a doubt. This information has been sent to me from America, and is printed, but has not been published.

19. I notice that this information as to the effects of the action of the current on pipes has been entirely confirmed by Dr. Hopkinson; and he is a partisan for telephone companies?—We know that when the current jumps from one conductor to another action is set up. We have Professor Barrett's evidence, also, on that point.

20. We have to bear in mind that the evidence you are producing is all on one side?—I occupy an independent position. Professor Barrett also does. He is employed by the Corporation of Chicago to look after the interests of the citizens. His evidence may be looked upon as impartial. I know that injury will result to the Government if this tramway system is allowed to be proceeded with. I come to the Government and tell them so; and it is for the Government to say what they will do. I consider that the Tasmanian Government did a very wrong thing to allow the Tramway Company in that country to proceed in their operations so far as they did—allowing them to bring out their plant, and even to lay their lines, before they told them that they could not adopt the system, which they had got in working order. Some months ago, when the Hon. Mr. Ward and I were in Australia, we intended to go and have a look at the work. I warned the Hon. Mr. Ward that before long this would happen in New Zealand; and that was before I knew anything of the proposal of the Dunedin Tramway Company. We found that the work of laying the electric tramway in Tasmania would not be completed for a few months; but I saw the Superintendent, who told me all that was going on. Shortly after I returned to New Zealand the Superintendent of Tasmanian Telegraphs wrote to me saying that he had tried running a return copper-wire instead of using the earth to eight or ten telephones, and it worked admirably. I wrote back, saying it was the McClure system, and had been tried in America to obviate the difficulty of currents interfering with the telephone system. It was found that it would not apply to large systems. I told him that, and have heard nothing further from him on the subject. I have been told that they have had a run of the tram-cars, just for trial; and I have no doubt that they would realise that the result would be either one thing or the other—either the tram must cease or the telephone. You can see that the Government of New Zealand is not at all in the same position. We have warned the tram people what the result will be, and they are now holding their hand to find out their position. I am neither an expert on one side or the other. I have had over forty years' experience, and have had twenty-seven years in the Telegraph Department. If I were in your employ [speaking to the Chairman] and knew that your property was to be damaged, you would look to me for information.

21. I do not doubt that. Do you contend that your legal position is such that you have any right whatever to the use of the earth for your telephone?—I think that, having had undisturbed possession for a number of years, we have a perfect right to claim the earth. There is another question that has cropped up: We have been using the earth as the return for all the telegraph circuits. I have no doubt that if the traction system is allowed to be introduced with the one-trolly system, it will disturb our telegraph system also.

22. Have you heard of the Haale case, in Germany?—Yes; the Government there have not protected themselves: we have here.

23. *Mr. Lake.*] Why should you?—You [speaking to Mr. Lake], representing the people, have made it law. I do not know on what grounds it was given (the action against the German Government), except that they had no Act to protect themselves like we have here. When the men came out here with the telephones we were prepared for them. I think in equity that the German Government was perfectly right, and that the case should have been given in their favour. In Italy they have passed a law to the effect that all trams (electric) and electric light must have closed metallic circuits.

24. I understand that the Goverement insisted upon metallic circuits for telephones in Italy?—No; such was not the case.

25. Did you read the Cincinnati case? That was a case where they had the single-trolly system in operation, and an application from the telephone company was heard and judgment given

in favour of the telephone company, but the judgment has since been reversed?—No; I do not know of that case, as to its reversal of prior judgment.

26. *The Chairman.*] What about the multiple-system of exchange?—That would work very well here where you have an unlimited number of telephones; but I have come to the conclusion that there is no finality in this multiple exchange. The moment you reach the maximum that the cases will allow you have to pull the whole thing down and build it up again. The Hon. Mr. Ward and I have come to the conclusion that, rather than we should have any big exchanges in the town, we will split them up by classifying the subscribers, keeping each branch of trade or profession separate. By this means the telephone would be much more satisfactory in its working, and each business would have undisturbed possession of their wires, and not be subject to the delays at times such as now.

27. *Mr. Swan.*] It would not have an injurious effect?—No. The service would be just as good as it is now, as the road annunciators would always be ready to switch through at a moment's notice. The gain will be very material to subscribers who use the telephone constantly. The exchange here has been laid on my own system—it is my patent—and has been a great saving in time and cost of plant already.

28. *The Chairman.*] How do you account for the telephone working successfully in America, where there are so many single-trolly tramways running?—On some lines there the induction will not be so bad. Thomson says the electricity from tramways is destructive to a distance of five miles. Of course the tramways do not as a rule in all cases traverse the same routes that the telephone system would travel on. Our difficulty in Dunedin is this: The main tramway service is right up Princes Street. The tram people said to us: "Shift your lines into another street, and you will get rid of the interference." We would do so, but we cannot. Nearly one-tenth of the whole number of our subscribers are in Princes Street, and the wires are on the house-tops, no poles being used, and, accordingly, all the telephones find earth in that street. We would have to double the whole system. It would not be so bad in Wellington here, for the exchange is out of the city proper. We might get an occasional current.

29. With the return-wire would there be any improvement when conversing through the telephone?—There is very little difference, and in my opinion the game is not worth the candle.

30. *Mr. Lake.*] At Leeds it was said that the effect of the traction current was endurable?—The witnesses, as the *New Zealand Times* says, who have said this, are all for the men who make the motors and that sort of thing. They can see a great stoppage to their industry if this thing is not allowed to go on. I cannot understand why they cannot adopt some method to overcome this evil. I just thought it out a little, and I cannot see any difficulty in using the double trolley. In America, in some places (where they use single trolly) they have overhead railroads. They run on wooden sleepers.

31. *Mr. Earnshaw.*] If the electric conductors for the tram-lines were enveloped for the whole length in a tube, with the wires insulated, would it not obviate all difficulty?—No. Pure water is nearly a perfect insulator, that is, a bad conductor; but the moment it comes into contact with any substance, which in this case would be mud in the internal part of the tube, it becomes a conductor. (Taking silver: its conductivity as 100, pure water conducts less than one-millionth part as well.)

32. *Mr. Lake.*] It is quite certain that sooner or later there must be interference with the telephone system?—In the vicinity, Yes. But a tramway running down Jervois Quay, Wellington, for instance, I do not think would appreciably affect the telephones on the Terrace. With a delicate instrument you might trace it.

33. Are you aware that, in the evidence you were quoting from, a witness who was using Campbell's tram system is asked a question as to the relative cost, and he says infinitely higher than horses, but double that of any other form of electric haulage?—I thought that question would crop up, and I have come prepared. [See Appendix B.]

34. Have you any evidence regarding horse-power in any system?—No; but if I have it in any other books I will let you have it. [See Appendix C.]

35. As regards the question of the Dunedin tramways, it is one of the most important of the whole lot?—If it can be proved that they are going to lessen the cost by electric tramways, it would be.

36. *Mr. Earnshaw.*] I suppose the position you take up is this: That while you have prior possession you do not, as a matter of fact, interfere with the ground to any appreciable extent; but when the Tramway Company come into possession along with you, it would interfere with your possession?—It would considerably destroy our plant, in fact.

37. If you had a perfect return system of circuit, would the tram system still affect you?—No; only so far as what Professor Barrett says, that their making use of the earth would destroy our cables in time. We should have to shift them overhead. We cannot load our posts in this town any more—we have reached our limit. Overhead is vastly cheaper.

38. *Mr. Lake.*] Supposing the tramway system, carrying one set of wires on your posts, and an accident happened to that post—if they were blown down—would there not be some injurious effect, possibly amounting to a fire, by reason of the high pressure?—Yes. It would possibly burn up the Exchange. But I have taken care of that. There is a fuse in every telephone. (The Government have a Board of Control. I am really that Board of Control. Mr. Baron has to go on certain lines. I am not an enemy of the Traction Company nor of the Electric Lighting Company. I wish them to prosper, but I do not want them to interfere with the Government property.) If one of the telephone wires falls on their wire not much damage would be done. I have kept the Electric Lighting Company's wires below the telephone wires for safety's sake. I do not think we should get any damage from our wires falling. We have had experience here. A wire fell down, and one fuse went at the Exchange and the other at the subscriber's box, otherwise there would have been a fire.

39. Apart from that, would there be any possibility of danger?—Yes, certainly; so far as human life is concerned, by touching the fallen wire.

40. *The Chairman.*] Do I understand from you that, although the cost of the double-trolly system would be considerably more to the Tramway Company, they would gain by saving 33 per cent. of motive power?—Quite. I consider the single-trolly system a most wasteful one.

41. Therefore, in the course of some years, this saving alone would fully compensate for the extra cost of the plant?—Yes, it is my opinion that in five or six years there will be no such thing as single-trolly tramways.

42. *Mr. Swan.*] Is it only in the first cost that the difference comes in, or is the cost of maintenance greater?—I do not think the cost of maintenance would be greater. It has been a matter of course to make use of the earth for the return, but it is a big waste, as part of the force generated is uselessly expended. No electrical engineer can deny that. The resistance absorbs so much of the energy which should be expended in the motor.

43. *Mr. Lake.*] Mr. Gain, in his evidence, admits that in London the telephone companies are adopting the metallic circuits?—Yes; some of them.

44. Is not your system an imperfect one? And sooner or later you will have to alter it?—We will break up the Exchange; but that will not change our system of earth-return.

45. *Mr. Earnshaw.*] Is it because of the weight involved that you cannot increase the number of wires on your poles? You can get steel poles?—They are no good. There is no rigidity in them. An iron pole is not so rigid as a wooden one. Trussed iron poles are only used in crossing rivers. They could not be used in streets. You could not erect iron poles to carry all these wires in a base of sixteen inches square. For iron poles you require a very large base. Crossing rivers is another thing altogether.

46. You admit that if your system was perfect you would not require the earth at all?—Our system is good enough. I do not say that it could not be more perfect—namely, by having twin wires; but where we use the earth it is good enough for our purpose.

47. You admit that you can have a system without the use of the earth; but, because you are covered by an Act of Parliament you claim absolute control of the earth?—Exactly. We say to the tram companies: "Your adopting that system will interfere with us, and render our system good for nothing unless we spend double or treble the amount of the original cost upon it." If the tramway people gain the day, and are able to use the earth-return for their tramways, it will cost the colony £70,000 or £80,000 for the laying of twin wires for every telephone connected with the principal exchanges.

48. *Mr. Lake.*] The primary rights of the streets are for locomotion purposes?—I have nothing to do with that. You have passed an Act, and I shelter myself under it. I am the guardian of your property. The Electric Lines Act does not give us any power save to take possession of the kerbing. Wherever we cross the street we have to keep 18ft. above it with the wires.

49. You have no right to the subsoil?—No. The subsoil belongs to the public. I may tell you this, that if we had not the Act we would have the same battles as they have had in England. There is no doubt that, if the Government had no Act, they would require to get an injunction from the Supreme Court to prevent the tram people from destroying their property.

50. The whole of the streets are vested in the Corporation by the Municipal Act of 1886?—I can set you at rest on that fact. A municipal corporation in England tried to stop a telephone company from going overhead with their wires, because they claimed the street from the ground to the heavens. They went to Court and were defeated.

51. *The Chairman.*] Mr. Baron told us that one of the great points in recent telephone prospectuses placed before the public was a guarantee of complete circuit. That was one of the great inducements to get subscribers to the telephone?—This notification was in a propectus issued by a rival company in embryo, of which the late Duke of Marlborough was chairman, but it never came to anything. It is without doubt an advantage to have twin wires in the telephone system; but the other, if properly looked after is, within a very small percentage, quite as good.

52. Has not the Telephone Department received great complaints respecting faults in the present service?—Yes, at times, but more so in wet weather. It was not until after some time that the cause was found out. I make all my own cables here. I import the wire and make it up, and the total cost is 20 or 30 per cent. less than if I imported the cables manufactured. I use nothing but the best wire, and I import it all in single strands and spin it up here. In the manufacture here, although the supervision is very careful and close, sometimes a mistake will occur, and a wire be rendered good for nothing. But these are mistakes which will always happen.

53. The Committee have been told that a number of telephone subscribers would be willing to pay something more per annum if this complete metallic circuit was given them. Has the department received any information of it?—No. I know nothing about that. It is the first time that I have heard anything about it.

54. Do not merchants object to having what they say through the telephone heard by others?—There is very little cause for complaint on that score. We have long stretches—seven, eight, and ten miles—in connection with the exchange, and they work very satisfactorily.

55. Do you approve of the McClure system, where all the wires are joined up to one common return?—Yes; it is a good one so far as it goes. It becomes unmanageable, however, when you come to a system where there are a large number of wires. In Dunedin, take Princes Street: we run wires across that street in many directions. Every one of those return wires is connected with a water-pipe. Just picture our running a copper wire from every telephone across that street to pick up the other pole of the telephone (the return wire). If it were only eight or ten it would be nothing, but there are nearer a hundred. I do not take any antagonistic interest in this affair at all. I see certain damage coming to the public property, and it is my duty to warn the Government.

56. *Mr. Swan.*] Does the objection to the single trolly apply to the double trolly also?—No; the double trolly is not in connection with the earth. The single-trolly system makes the earth the medium for return, and the electricity spreads over the whole ground. Knapp, in his "Electric Transmission of Energy," page 290, says, in reference to this question of conductor: "Mr. Holroyd Smith has overcome the difficulty by placing the conductor underground. Where batteries are used each car is perfectly independent from all the other cars, and this is a great advantage in working over a complicated net of tram-roads. After this rapid comparison between the two systems, we may sum up by saying that the conductor system is better for lines running across country where the overhead conductor and high electric pressure can be used without difficulty, and the battery system is better for tramways within the crowded streets of a city." There is no doubt that they will perfect this battery system and you will get 60 per cent. or 70 per cent. of the cost back. We are using dry batteries now in the telegraph. We have batteries now set up that have been two and three years in use, which is a great saving. There are not at present any perfect accumulators. The accumulator will in time play a very important part. At present you spend £100 and only get £25 back from it.

TUESDAY, 12TH SEPTEMBER, 1893.

Mr. SUCKLING-BARON re-examined.

1. *The Chairman.*] The Committee are now prepared to hear you, if you wish to make any further statement?—Since I last gave evidence before you the report of the Select Committee of the House of Commons and the House of Lords on the question under discussion has been printed. This report, in the first place, opens up the way to the more rapid and more reasonable development of the methods of traction by electricity along our streets and roads than has hitherto been possible. In the second place, it practically compels the telephone service, whenever disturbances arise from an electric tramway, to rearrange its system within two years on a plan which is confessedly the only one which gives complete satisfaction; which ought to have been adopted at the outset, and which, even now, at certain points, is in process of reluctant installation at the instance of outraged and long-suffering subscribers. The report recommends that tramway companies should either use the insulated return, or the uninsulated return of low resistance. Uninsulated metallic returns of low resistance are practically in use to-day on the majority of successful lines. It is obviously in the interest of an electric tramway to have the return circuit of as low a resistance as possible. It is clearly in the interest of the station manager, who is responsible for the working of the line, that this should be the case. In order to obtain a really low resistance it is necessary to have proper "bonding." The present mode of bonding is to connect every length of rail by a copper wire of a certain cross section. There was some difficulty at first in getting an effective bonding. This difficulty has now been got over. If a bond of larger cross-section than has hitherto been used is insisted on, there should be practically no resistance in the bond itself. The bonding should be carried out well in the first instance, and properly maintained afterwards. Mr. Swinburne, in the report, made a very common-sense remark that "the streets of our cities and towns were primarily laid out for traffic, and not for talking through." The discussion results in this question: "Shall we have cheap traction or defective telephones." If we are to have cheap traction we must have the single trolly, for that is the cheapest and the most efficient system of electric traction there is. If we are to have the best telephone system, the telephone companies must use the metallic-return. Either cheap traction or bad telephony—there is no other alternative. In a case at Folkstone, where the cost of insulating the tramway system was discussed, the decision of the Committee on the subject was that if the Telephone Company required this done they must themselves pay for it. The Telephone Company refused the clause suggested by the Committee, and allowed the Bill to pass without any protection to themselves, and, as a consequence, had to pay the promoters' costs. On the 7th of May a Committee of the House of Lords, appointed to inquire into the merits of a Bill promoted by the Dublin Southern District Company to empower them to acquire the lines of the Blackrock and Kingstown Tramway Company, and to use electric power on the entire system, reported in favour of the third reading of the Bill. This was a case where the single trolly was to be used; there was no special protective clause for the Telephone Company. It has been said that the return current from the tramway system would affect the railway signals; but any interference with railway signals can be, and, in fact, has been successfully guarded against, and at a comparatively trifling expense, by duplicating the wires for block signalling. And, with regard to the corrosion of gas- and water-pipes, I feel quite sure that this is so remote a contingency that it need hardly to be taken into account. It is not the tramway companies, nor the gas and water interests, which are opposed to electric traction; it is solely the telephone companies, and they object to it because it brings into strong relief the imperfection of their system. The evidence on this subject was quite overwhelming, and it was conceded by all the witnesses called, that the adoption of metallic circuits is at least advisable, if not absolutely necessary. Mr. Preece, Engineer-in-Chief to the General Post Office in England, and who is responsible for all the trunk telephone lines running all over over the kingdom, said that "the English people were ashamed of the telephone, and that no more execrable and abominable service existed in the whole world than the telephone system of London." With regard to the electrolytic action on gas- and water-pipes, Mr. Hesketh, Electrical Engineer to the Blackpool Corporation, was examined by Mr. Worsley Taylor on behalf of the municipal corporations. He said that all the main streets at Blackpool has been taken up during the last month, and he had seen no electrolytic action. At the request of the Board of Trade they had placed the negative pole to the rails in order to prevent any possible electrolytic action. He had never found any interference with the telephones from their tramway; nothing to make conversation difficult. It was unnecessary that tramways should be required to use insulated returns. The difficulties in the crossings and the

turnouts would be very great. The telephones at Blackpool had earth-return formerly, and the Corporation had altered the local exchange to the double-wire system. The tramway carried over a million of passengers last year; and on the part of the Corporation he deprecated any obstructive clauses. The following is interesting:—

"*The Resistance of Return-circuits in Electric Street-railway Practice.*

"To test the question of what constitutes efficient and economical bonding of the rails of electrical tramways which serve as return-conductors for the electric current, a large series of observations were taken on several lines in which different systems had been adopted. The measurement of the resistance by an ordinary Wheatstone bridge was found to be attended with certain difficulties, owing to constant or varying local electro-motive forces, and the observations were therefore carried out by determining the drop of electro-motive force over a certain distance with a given current. The results of five different tracks are detailed, with full descriptions of the bonding used in each, and conditions of weather, &c., the final figures, reduced to resistance per mile for a double track, being as follows:—

	Ohm.
(*a.*) No bonds, dry	0·7675
(*b.*) Bonded and cross-connected, no continuous wire, dry	0·0797
" " " wet	0·0717
(*c.*) Bonded, continuous wire, wet	0·0207
(*d.*) " " dry	0·0254
(*e.*) Bonded, no continuous wire, dry	0·0577

"(*b.*) was bonded with iron wire of different sizes, but principally of No. 3 gauge; (*c.*) was bonded with No. 3 copper wire, riveted to rails, and soldered at each bond to a continuous copper wire of same gauge, and rails cross-bonded every 200ft; (*d.*) was similar to (*c.*), but the bonds were soldered to rails as well as riveted, and the cross-bonds at more frequent intervals; (*e.*) was bonded with two No. 4 galvanized-iron wires. The figures show at a glance the necessity for some form of bond, and further, the advantage of doing it in a solid manner by using copper; the rail-section does not enter appreciably into the resistance, as the calculated resistance of the bonds accounts for almost the whole of that observed."

This shows that if the bonding is properly carried out that a track of practically unlimited carrying power would be afforded. It will be noticed that in case (*c.*) the resistance of one mile of rail was only 0·0207 of an ohm, or one-forty-eighth of a unit; and I am sure that no test taken in New Zealand will show an earth-resistance of less than ten units, and in many cases twenty units: say ten units; then the earth offers a resistance of 480 times greater than the tram-rails, and I leave you to judge what current is likely to leak to earth, if it follows, as it must, the electrical law that the quantity of current flowing in a circuit is inversely proportional to the resistance of that current.

"Attention has again been drawn to this subject in a paper read by Mr. C. H. Morse before the New England Waterworks Association, in which he refers to the injury done to water-pipes in and about Cambridge, Massachusetts, from the cause above-mentioned, and the attempts which have been made to overcome it. The most obvious remedy is that of grounding the negative side of the generators, so that the current enters the pipe from the ground, instead of emerging from it, as would be the case if the positive were grounded. This has been tried with good effect, precaution being taken, however, to make the connection between the water-pipes and the power-house so that there shall be practically no difference of potential at this point; or, in other words, that the current would take to the conductor in preference to the earth. Evidently the principle embodied in this construction is the one underlying the whole question of immunity from the deleterious effects of electrolysis. . . . It having been shown that in many instances the current takes to the water-pipes and other conductors in the ground by preference, it must be obvious that if the current can be made to return to the generating point exclusively by such conductors without utilising the earth, all difficulty will be obviated."

Hitherto, tramway companies, not knowing that it mattered which pole of the generator was grounded, indiscriminately connected one or other to earth, and hence all the damage which had been referred to in newspapers. None of that damage could have been done if the negative terminal had been connected with rails laid down as I have stated. If there was electrolytic action the rails would be dissolved and the water-pipes protected; and in the case of the Dunedin Council, as the water- and gas-pipes belong to them, I think they can safely rest content. The Select Committee of the House of Lords, after obtaining all the best expert evidence possible to be obtained in Great Britain, state in one clause that if the negative terminal of the generator (?) is connected to the earth, any damage by electrolytic action either to gas- or water-pipes will be practically negligible. It may be said in countries where there is much snow or mud there is a difficulty in making good contact between the wheels of the tram-car and the rails. But that is a difficulty easily got over; many cars carry a water-tank in front to wash the rails. A brush may also be placed in front of the car to clean the rail, and a metallic brush may be placed behind in contact with the rail to assist the wheel-contact. Complaints have been made, from time to time, of electrolytic action between gas- and water-pipes in houses. The telephone companies immediately rush to the conclusion that this must be caused by the tramway companies using ground-returns. As a matter of fact there is electrolytic action going on between all gas- and water-pipes in all houses; and this is easily found out by taking an ordinary telephone and connecting one terminal with the gas-pipe, and if when slightly touching the water-pipe with the other, you hear a "clicking" noise in the telephone, this will show that there is a current passing between the two systems; and in some cases a conversation may be carried on, and distinctly heard, over a distance of several hundred yards, the gas-pipe acting in one case as the conductor, and the water-pipe in the other. I mentioned in my last evidence that in Germany, where the whole of the telephone and telegraph

systems are owned by the Government, that a company at Halle had obtained a concession for a single-trolly system, and that the Government refused permission to the company to carry out its project. The matter was taken into the Law Courts and the Government was defeated. Since then electric railway systems have been put down in the principal towns of the same country, namely, Bremen, Gena, Remschied, and Essen. Over and over again the telephone companies have cited, in their own interest, the case of electrolytic action on the system of pipes owned by the New England Waterworks Association in America. Some little time ago authorative tests were taken to try and fathom the real cause, and it was found that out of 500 volts used by the tramways, not less than 25 volts were leaking to earth. A leakage like this is abnormal, and would account for all the electrolytic action; and I feel confident that if many other cases were tested, the same effective answer would be given. The tramway companies, if they had been aware of such leakage, would have remedied the fault. It seems very hard that tramway companies which have already laid down a return of low resistance in the shape of the rails, and their connections, should be asked to put down another. The tramway companies naturally say that they do not want any leakage to earth, and that even if they doubled their wire there would still be no guarantee of absolute insulation. Legislation may insist on a metallic-return for tramway companies, but this would not protect telephone systems. As long as they use earth-return, the system would always be subject to disturbance caused by leakage from any electrical circuit, whether used for electric-light or electric-power purposes. The Select Committee of the House of Lords saw these consequences, and that if they insisted on a metallic-return for electric curcuits they would thereby unnecessarily impede the whole progress of electric traction. Mr. Preece, who appeared before the Select Committee in favour of the telephone companies, or rather in telephone interests generally, stated that the English Government had actually refused to connect any branch telephone system with the trunk lines which they were putting down all over Great Britain, unless such branch-lines had a metallic circuit. In the evidence given by Dr. Lemon, I note he has given you quotations from a book, by Mr. Gisbert Kapp, entitled "Electric Transmission of Power," on the cost of working electric roads; but I do not think the information given in the edition he has quoted from is up to date. The following figures are later:—

"Comparison of Investment and Operating Expenses.

Table I.

—	Total Investment Real Estate: Road and Equipment.		Car-miles run per Annum per Mile of Street Length.	Passengers carried Annually per Mile of Street Length.	Passengers carried per Car-mile run.
	Per Mile of Street Length.	Per Mile of Track Length.			
	$.	$.			
22 Electric Roads * ...	38,500	27,780	76,158	237,038	3·10
45 Horse Roads † ...	33,406	31,093	43,345	251,816	5·81
10 Cable Roads ‡ ...	350,325	184,275	309,395	1,355,965	4·38

Table II.

—	Operating Expenses per Car-mile run.	Interest-charge per Car-mile at 6 per cent on total Investment.	Total of Operating Expenses and Interest per Car-mile.	Cost per Passenger carried, Interest excluded.	Cost per Passenger carried, Interest included.
	Cents.	Cents.	Cents.	Cents.	Cents.
Electric Roads	11·02	3·03	14·05	3·55	4·53
Horse Roads	24·32	4·62	28·94	4·18	4·98
Cable Roads	14·12	6·97	20·91	3·22	4·77

* Car-miles run per annum, 14,013,187; passengers carried per annum, 43,614,972; street lengths, 184 miles track length, 255 miles.

† All the roads in Massachusetts operated exclusively by horses for 1885–90. Average for six years.

‡ From Census Bulletin No. 55.

Table III.

—	Ratio of Investment per Mile of Street Length.	Ratio of Car-miles run Annually per Mile of Street Length.	Ratio of Cost of operation per Car-mile, Interest included.	Proportional Traffic that must be done per Mile of Street occupied, to pay Operating Expenses and 6 per cent on the Investment.
Electric Roads	1·152	1·757	0·485	0·852
Horse Roads	1·000	1·000	1·000	1·000
Cable Roads	10·486	7·138	0·722	5·154

The National Telephone Company, which practically owns the whole of the telephone systems in England except the trunk lines, have openly stated that they are aware that in a very short time they will have to use metallic-returns in all cases. At their last general meeting they carried a large sum forward to reserve fund in order to be prepared for such an event. The Town Clerk of Wallsall, in his evidence before the Select Committee, stated that the Corporation had replaced steam by electricity with highly satisfactory results, and with this result particularly, that they had, by means of the change, carried an increase of 95,000 passengers within a period of five months. He said that if they had to choose between doing away with the tramways and the telephones the telephones must go. Major Cardew, electrical adviser to the English Board of Trade, a man of great and varied experience, considered that if the negative terminal was connected to the rails the effect on the gas- and water-pipes would be negligible. In answer to Sir Bernhard Samuelson, he stated that in the case of the Leeds tramway, and in two or three other cases, this connection had been made at his suggestion; and, when that was the case, any current passing between the electric system including the rails and water-pipes would tend to corrode the rails, and preserve the water-pipes. I am sure the tramway companies do not mind that possiblility. Mr Molley, in his evidence before the same Committee, stated that electrolytic action could be avoided with ordinary care, and that no danger was to be anticipated by reason of a large extension of electric traction if only proper precautions were taken, and that regulations could be drawn up so as to secure this. For myself, I think if ordinary care is taken in laying the rails, and copper wire of proper cross-section is used, and the copper properly bonded with the rail, and the tram-rails connected with the gas- and water-systems surrounding, and the negative terminal connected to the rails, the tram-rails would offer such a low resistance to the return-current compared with the earth that there would be practically no leakage. Should there be any leakage, then the current would leave the rail and enter any of the underground cables or water-pipes, and the action would rather tend to preserve any such pipes or underground cables. A great deal has been said about the expense of converting the telephone system from one of earth-return to one of metallic-return. It might possibly be argued that it would be necessary to take down existing poles and put up larger ones to make way for an increased number of wires, consequent on the use of the metallic-return system. But if the present telephone wires running to subscribers were put into a cable, as you can see in Wellington, each containing twenty or thirty wires, the present poles would be capable in many cases of carrying wires for all after extensions.

2. *Mr. Earnshaw.*] Your evidence is the opposite of Dr. Lemon's statement. I would like to call your attention to the evidence you gave before, as to connection of the rails for the return-circuit. Dr. Lemon pointed out to this Committee that, owing to the antagonism between the metals, the connection would become defective, and the current must go in to earth. I asked the question whether, if the whole of the rails were insulated by some non-conductor, the current would be prevented from going to earth. He contended that under no circumstances could you stop the electric current from going to earth. I want to know if that is the case?—The reason there has been any electrolytic action on the gas- and water-pipes is because there has been leakage from the tramway to earth. The reason for this leakage is because the tram-rails have offered a higher resistance than the earth has offered. But in every successful system of tramway the rails are of low resistance compared with the earth. In the model clauses to be adopted by the Board of Trade they would insist on the return-circuit being of a certain maximum resistance, and you may depend there will be inspection provided to see that the clauses are complied with. The rail, under these clauses, offering a low resistance, would prevent any tendency of leakage to earth. Consequently the pipes would not be affected. As to the statement that copper joined to an iron rail would become defective, I contend that if the bond is good this would not happen. If there is any objection to copper properly bonded—I have not heard of any—then the iron may be used. The resistance of iron is six to seven times that of copper, so that the section of the iron bond must be much greater than the copper bond, but the iron would cost less than copper, so that the cost of connection by using iron bonding would be less. Copper is, however, preferable. As to insulating the rail, if you insulate you may just as well insulate a return overhead wire.

3. *Mr. Moore.*] Suppose in bad weather your line is flooded, what would be the result?—The result would be in favour of the tramway; in wet weather the tram wheels would make better connection with the rails.

4. Would not water conduct the electricity away from the rails?—The electric current will take the path of the lowest resistance. If the metal is properly bonded the current will have no tendency to go in another direction as long as the wheel makes proper contact with the rail. As long as there is a low resistance in the rail the current will not flow back by the earth.

5. Assuming any defect to take place in regard to the return conductor, or suppose the rail is made almost perfect: would there still be, owing to some unperceived defect, a tendency of leakage to earth?—In order to prevent leakage caused by defective bonds, cross connections from rail to rail could be made, so that if one bond was out of order the current would be returned by another rail. In many cases a centre wire has been run down the track, which answers the same purpose.

6. *Mr. Earnshaw.*] I assume that you have instruments by which you could test the line at any time as to whether there was a break in the connection?—Yes.

7. And that you could locate the break of connection if there were such break?—Yes.

8. But can you locate the defect or injury if it exists?—Yes; we can then take an insulation test, and can practically locate the fault by cutting out sections of the line.

9. I have asked you this question because, in case of any flow of electricity to the earth, it is very desirable to know that no lengthened period could elapse during which there would be an escape of electricity to the ground without your realising the fact and rectifying it?—We can discover any defect of the kind and rectify it.

10. *Mr. Lake.*] I understood you to say that the gas and water companies practically raised no objection before the Committee?—I said it was not the gas and water companies that so strongly opposed the single-trolly system, but the telephone companies. The gas and water companies would not have taken the subject up had the telephone companies not brought the discussion to the front.

11. You are aware that the water companies did propose a series of clauses, in which they insisted that there should be no connection whatever made with water-pipes or gas-pipes?—These were proposed, but they were not recommended by the Committee, as they were not thought necessary.

12. Would the single-trolly system be increased in expense if the regulations of the Board of Trade are carried out—I refer, of course, to the clauses to be inserted by the Board of Trade?—Not very much; for in all successful lines the greatest care is taken to have the bonding wire of the proper section, and under proper inspection.

13. Take the case of Dunedin: would it not tend to enlarge the cost if they were compelled to carry out the recommendation of the Parliamentary Committee, or any similar recommendation?—Not if the contractor had made proper provision for putting down the return as it should be put down. I have no doubt it will be put down with all such provisions. The contractors have all the necessary experience. I cannot, of course, say what system of return they have provided for. If they perform their contract efficiently, according to their skill and experience of what efficiency requires, any clause put in by the Board of Trade for the protection of the various companies should not materially affect the cost.

14. How do you propose to get over the constant gaps in the return-rail, which will be caused by the expansion and contraction of the metal?—If the rails expand, the connecting-wire would expand in a certain ratio. Eighteen inches from the end of each rail a taper hole is drilled and the end of the copper bond is passed through and wedged up with a taper plug from the outside.

15. Will it not be practically impossible to secure rails against corrosion at the point of contact?—There will be no corrosion if the track is laid as I have stated.

16. Do you think that such connection as you speak of will comply with the clauses in the report of that Parliamentary Committee?—Yes, I do.

17. Do you think that anything but insulating the rail will be sufficient?—Yes.

18. *Mr. Moore.*] When you were referring to the report of Mr. Hesketh to the Blackpool Corporation, you said that the water-pipes had been examined and no damage had been found. Do you know how long the tramway had been working, and how long since the pipes were laid?—The tramway has been working about five years at Blackpool.

19. What return had they in connection with this tramway; was it copper with which they connected the rails?—I am not sure; I do not think it is a single-trolly; but they use the earth-return as return; I think it is a conduit system, they have a central rail.

20. Would the leakage be very much in a case of that sort?—There are difficulties; if water gets into the central duct it will cause leakage.

21. Would the brush in front, that you have referred to, have the desired effect of keeping the rails sufficiently clean to prevent leakage?—Yes, and the metallic brush I spoke of would help the electrical contact.

22. *Mr. Lake.*] The second brush would be, in fact, an electric conductor?—Yes.

23. *Mr. Moore.*] Have you any experience of your own as to the damage that might accrue to water- or gas-pipes from the introduction of the electric tramways?—No; most of my opinions on that subject have been formed from statements made by practical men working tramway systems.

24. Had you any opportunity, when you were in America, of seeing any water-pipes after the tramway had been working any length of time?—No; I had not.

25. Do you know if any have been taken up and examined?—I have heard of some damage reported in Chicago, but the whole thing can be explained.

26. *The Chairman.*] Is it only a recent examination that has disclosod that?—No.

27. Is there any recent case that has come under your notice?—I have read Professor Barrett's report. He is the engineer to the Chicago Corporation, but I do not know whether he has any such qualifications as Major Cardew and others who gave evidence before the Select Committee.

28. But if his report be correct you must admit that some damage has accrued?—I admit that considerable damage has been done, if his figures are correct; but that damage could have been prevented, and is not likely to occur again.

29. You think, then, that damage could be provided against?—Yes.

30. *Mr. Swan.*] Did Mr. Preece advance any argument in support of his wholesale comendnation of the London telephone companies?—Yes; I have already quoted what he stated, and any one who has used the telephones there will say the same thing. It is practically impossible to hear distinctly over the lines during half the day. There are so many wires running from electric-light and power stations, wires from telephone exchanges, &c., in London, that the induction is very great. All that would be got over if there was the metallic-return to the telephone systems.

31. *Mr. Lake.*] Is it not the fact that lately private companies who have used the earth have run away with the business of the Government?—I do not think that many cases exist where the Government work in opposition to private companies.

32. But where they have been using the earth they have been able to do the work cheaper than the Government?—Very possibly, because they may work over a larger district. If subscribers had the choice of paying for the metallic-current system an annual subscription of, say £7, and of say £5 for the earth-return system, they would, I believe, choose the former.

33. *Mr. Earnshaw.*] With regard to the connecting-wire, and the return of the electric current to the generator, would you think it too much to demand of the Tramway Company that in putting

down their line the system should be made as perfect as possible; that every thing should be done in the most perfect manner? I am speaking now of Dunedin: whatever arrangement may be made is it too much to ask that the return-circuit should be made as perfect as modern experience requires? —I do not think that the company in question, with the reputation which they have, would do anything else than put down the best system.

34. All your evidence goes to negative the liability to danger; and, where accident or damage has occurred, you say that they could have been avoided if ordinary precautions had been taken?—Yes.

35. *Mr. Lake.*] Assuming an electric tram, established according to the orders of the Board of Trade, it might be impossible to run such tram so long as the Government claim that there should be no interference with the telephones?—Yes, possibly.

36. However good the return, the telephones would be affected by the induction, and they would have to have a return-wire to them?—Yes; if they wish to possess an efficient service.

37. But you assume that the present service will not be much interfered with?—Yes.

38. *The Chairman.*] In that Parliamentary Committee Report a cardinal point was made in connection with the recommendations that the electric companies should have time to protect themselves by insulation?—Yes.

39. Do you think that it could be managed in less time—two years?—Yes, certainly; the probability is that the clause was framed to apply to large cities; but in such places as Dunedin and Wellington, or in any part of New Zealand, where there are so few telephones comparatively, I do not see why the whole thing could not be done in a year; in the meantime the tramway line could be under construction.

APPENDICES.

APPENDIX A.

EXTRACT from the DECISION of Justice KEKEWICH, in the Leeds Tramway case.

[From the *Electrical Review* of the 10th February, 1893.]

"THE principle is thoroughly well settled here, and my duty is merely to consider whether it is applicable. It would be easy, of course, to point out differences between all the cases to which it has hitherto been applied and the present; and I have already said that injury arising from such a case as the discharge of electric current can scarcely have been contemplated by any Judge in previous cases. But, after reflecting much on the novelty of the case, on the arguments addressed to me, and on the peculiarity of an electric current as distinguished from every other power, I fail to see any reason why the principle should not be applied to it. I cannot see my way to holding that a man who has created, or, if that be inaccurate, called into special existence, an electric current for his own purposes, and who discharges it into the earth beyond his own control, is not as responsible for damage which that current does to his neighbour as he would have been if he had discharged a stream of water. The electric current may be more erratic than water, and it may be more difficult to control its direction and force; but when once it is established that the particular current is the creation of, or owes its special existence to, the defendant, and is discharged by him, I hold that, if it finds its way on to a neighbour's land, and there damages the neighbour, the latter has a cause for action. At any rate, I think that if a distinction is to be taken between this and other forces for this purpose, that distinction must be made by a higher tribunal, and not by a Judge of first instance. It was endeavoured to be argued, on behalf of the defendants, that the current injuring the plaintiffs was only part of the general body of electricity which may be now said to exist everywhere, and to be proceeding in every direction; but the effect of the defendants' operations is to collect a particular portion of this body, and to discharge it into the earth at a particular spot, and there can be no doubt but that the disturbance of the plaintiffs' telephonic system is caused by the particular quantity thus discharged. Assuming the action to be maintainable, on the principle of Fletcher *v.* Rylands, the defendants rely on two answers to the plaintiffs' claim. First, they say that the plaintiffs might, by an alteration of their system—that is, by the adoption of what is known as the metallic return—prevent the disturbance complained of; and, secondly, they say that they, the defendants, are acting under statutory powers, and that if, in the proper exercise of those powers, they injure the plaintiffs, they are free from blame. The first answer is, to my mind, without foundation. The man who complains of his land being thrown out of cultivation by the incursion of water escaping from his neighbour's reservoir must not be told that he has no right of action because, if he had interposed a wall, or otherwise taken care to protect himself, the water would not have reached his land. He is using his land in a natural way, is not bound to take extraordinary precautions, and is entitled to rely on his neighbour also using his land in a natural way, or, if he uses it otherwise, take extraordinary precautions to prevent damage to others therefrom. There is no doubt a body of evidence to show that a system different from that adopted by the plaintiffs has been adopted elsewhere with advantange, and may possibly prove to be the most convenient, though more expensive for them; but the evidence also proves that their present system has been largely adopted, and is received with favour by many competent to form an opinion. It also has the merits of economy. They are carrying on their own business lawfully, and in the mode which they deem best; and I cannot oblige them to change their system, because they might thereby possibly enable the defendants to conduct their business without the mischievous consequences now ensuing. True it is that the analogy introduced above fails to this extent: that the plaintiffs are using the law for an extraordinary purpose, but, admittedly, it is a lawful purpose; and, though under an obligation to obviate mischief from their own operations to their neighbours, they are under none, in my judgment, to protect themselves from the defendants or others. The outflow from one reservoir might easily destroy another; but, so far as I am aware, there is no principle or authority in English law for rejecting a claim for damage by the owner of the latter on the ground that his user, as well as that of his neighbour, is extraordinary. The second answer of the defendants to the plaintiffs' claim has required more examination. Having recently had occasion, in Allison *v.* City and South London Railway Company, and again in Rapier *v.* London Tramways Company, to consider such a plea as is here put forward, and to consider many authorities—and, in particular, the cases of Metropolitan Asylums District *v.* Hill (6 App. Ca. 193), and London, Brighton and South Coast Railway Company *v.* Truman (11 App. Ca. 45), and their application to different provisions and circumstances, I do not find it again necessary to state my view of the law, or of the lines by which I ought to be guided in applying it to a particular case. Therefore, I shall but briefly explain the reasons for my conclusion that the defendants' plea is good in law, and that they are not responsible to the plaintiffs for the mischief caused by their works. The defendants' authority is derived under a provisional order confirmed by Act of Parliament. Such provisional orders in connection with tramways, and many other undertakings of a public character, are now common, and, I think, must be treated as a 'well-known and recognised class of legislation,' equally as much as the Railway Acts, which were referred to in those terms by the Lord Chancellor in London, Brighton and South Coast Railway Company *v.* Truman (11 App. Ca. 53). The Railway Acts (again using the language of the Lord Chancellor in the same case) were assumed to establish the proposition that the railway might be made and used, whether a nuisance were created or not; and, in my judgment, a like proposition

must be assumed to be established by the provisional orders, one of which is here under consideration. The defendants are expressly authorised to use electrical power; and the Legislature must be taken to have contemplated it, and to have condoned by anticipation any mischief arising from the reasonable use of such power. A distinction was endeavoured to be made between cases where extraordinary powers are directly sanctioned by the Legislature, and those where it is left to some other authority (in this instance, the Board of Trade) to determine whether, if at all, they may be brought into operation. It is within the competence of the Legislature to delegate its authority; and, when once that delegated authority has been properly exercised by the agent to whom it is intrusted, the sanction is that of the Legislature itself, just as much as if it had been expressed in the first instance in an Act of Parliament. The defendants relied on the 51st section of the provisional order. They argue that the exception there made in favour of the telegraphic, which would include telephonic, lines of the Postmaster-General indicates that interference with any other like wires was intended to be permitted. The reference supports the more general argument, and I have therefore mentioned it; but I rest my decision more on the established principle laid down in many cases, and ultimately ratified by the House of Lords in London, Brighton, and South Coast Railway *v.* Truman. To that plea of statutory power the plaintiffs' have a rejoinder. They say that such power cannot avail the defendants, unless they have acted reasonably in the exercise thereof, and have done their best to avoid injury to their neighbours. The argument being sound in law, one is compelled to examine the facts. The defendants work their tramways on what is called "the single-trolly system." There are other systems which have from time to time been used and, it seems, are still in use elsewhere, and there are at least some good reasons for the conclusion that, by the adoption of one or other of these systems, the defendants might wholly or partially avoid the mischief which they now occasion. There is a contest on the evidence whether any of these other systems can be regarded as good apart from comparison with that of the defendants, and there is a further conflict of evidence whether, if good, they are comparable in merit with that of the defendants. My conclusion from the evidence is that the defendants' system is, on the whole, the best which practical science has discovered, but there is no occasion really to go so far as this. It is enough to say—and about this I entertain no doubt—that it is at least as good as any other, and has been proved by experience, especially in the United States where there have been larger opportunities for experiment and consideration, to be as likely as any other to meet the requirements of traffic, and the convenience of all concerned in the protection of the site of tramways for the use of legitimate purposes other than those of the tramway undertaking. It cannot be that, in the application of the law which I am now considering, the Court is bound to hold a railway or other company liable for the consequences of acts done under statutory powers, because it has not adopted the last inventions of ever-changing and ever-advancing scientific discovery. It is surely impossible, with any regard to that commonsense which after all is the foundation of this and many other branches of law, to say that a railway company which was not liable last year, last month, or even yesterday—because until then, its undertaking was carried on according to rules acknowledged to be the best—it is liable now, not because those rules have been proved to be altogether wrong in practice or unscientific in principle, but because some diligent worker in this department has discovered what is held for the moment to be a large improvement, but may to-morrow turn out to be only a step in the progress of further advance; and yet this might be the necessary conclusion in many cases, and, indeed might be the necessary conclusion here, if I were driven to support the plaintiffs' claim on the ground that the single-trolly system, so largely approved where it has been largely tried, does not avail the defendants as a proper exercise of their statutory powers because another system is in use, and apparently successful use, in Buda Pesth or elsewhere. I do not wish to prejudice the question, whether a charge of negligence in the exercise of statutory powers can be supported by cogent evidence that the company exercising those powers has failed to adopt alterations or precautions, which sufficient experience has shown to be of large indisputable and permanent value. That question may easily arise in many of the disputes which are likely enough, from time to time, to occur between public companies and those whom their operations injuriously affect; and it may even arise between the parties to this litigation. Suffice it to say that it does not arise now. Holding on the above grounds that the plaintiffs cannot maintain an action, either for an injunction or for damages against the defendants, I must order them to pay the general costs. If ever there has been or can be a case to which the distinction between the two scales of costs is properly applicable, this is the one; and the costs must be taxed on the higher scale. But it remains to make an exception, and that of some extent. I have already stated that the interference with the plaintiffs by the defendants is beyond doubt. I do not think that this ought to have been litigated. Mr. Macrory's report shows that one fair experiment would have proved the facts, about which there really was very little doubt, independent of his report, and that much time was uselessly spent on evidence. Not only must the plaintiffs be excused payment of the defendant's costs of this issue, which must be defined to be the issue whether the plaintiff's telephone system was in fact interfered with by the defendant's operations, but the costs thus excepted from the general costs of the action must be borne by the defendant and set off. These costs will, of course, include those incurred in the experiments conducted at Leeds under Mr. Macrory's superintendence. They must also include the fee payable to Mr. Macrory, which it was agreed I should settle. I have communicated with him and ascertained the time occupied, and also the expenses incurred by him in railway journeys and the like, including the expenses of the gentleman (Mr. Cunninghame) whom he asked to assist him; and, taking into consideration these items, I have fixed the fee at 50 guineas to cover all expenses, and also such fee as he thinks fit to pay Mr. Cunninghame. I am glad to think that the course pursued with the concurrence of both parties of sending him down to make experiments and report was not only successful in finally settling an issue of fact, but also shortened the trial and saved the further costs which further dispute on this point would necessarily have involved. There will be judgment for the defendant, with costs, modified in the manner above expressed."

APPENDIX B.

EXTRACT from Knapp on "ELECTRIC TRANSMISSION OF ENERGY," Pages 231, &c.

THERE are four systems of importance for long distance transmission: The electric transmission of energy; the hydraulic transmission of energy; the pneumatic transmission of energy; the transmission of energy by wire-rope.

* * * * *

The COMMERCIAL EFFICIENCY is :—

Distance of Transmission.	Electric.	Hydraulic.	Pneumatic.	Wire-rope.
For 100 metres	·69	·50	·55	·96
" 500 "	·68	·50	·55	·93
" 1,000 "	·66	·50	·55	·90
" 5,000 "	·60	·40	·50	·60
" 10,000 "	·51	·35	·50	·36
" 20,000 "	·32	·20	·40	·13

It will be seen that for distances less than 5 kilometres (about three miles) transmission by wire-rope is more economical than that by any other system. For distances greater than 5 kilometres the electric transmission is most economical. As regards capital outlay, the wire-rope system is also for short distances more advantageous than electric transmission, the limit being at about three kilometres (a little under two miles). Beyond that the electrical system is the cheapest, as will be seen from the annexed table :—

CAPITAL OUTLAY in POUNDS STERLING reduced to One Horse-power.

Maximum Horse-power transmitted.	System of Transmission.	Over a Distance of					
		100 M.	500 M.	1,000 M.	5,000 M.	10,000 M.	20,000 M.
5 ...	Electric ...	75	78	81	108	142	210
	Hydraulic ...	41	66	97	358	610	1,280
	Pneumatic ...	73	96	210	600	1,090	2,060
	Wire-rope ...	6·5	31	61	305	760	1,220
10 ...	Electric ...	52	54	56	77	103	154
	Hydraulic ...	30	45	65	220	416	806
	Pneumatic ...	60	72	88	213	369	680
	Wire-rope ...	5·1	23	47	231	460	925
50 ...	Electric ...	40	41	42	55	69	100
	Hydraulic ...	16	21	30	91	170	325
	Pneumatic ...	31	36	42	88	147	265
	Wire-rope ...	1·8	7·2	14	69	136	272
100 ...	Electric ...	32	33	35	45	59	87
	Hydraulic ...	14	20	28	88	164	310
	Pneumatic ...	26	30	34	67	109	192
	Wire-rope ...	1·1	4·3	8·4	41	81	162

The table shows that for short distances the cost of electric transmission is very considerable as compared to that of the other systems. The reason for this is that the prices of dynamos and motors have been rather overestimated, as already mentioned. For long distances this is not so noticeable, as the conductor forms the more important item, and especially since an electric wire is cheaper than an equivalent hydraulic or pneumatic tube. If we compare the conductors only, we find that for the transmission of 10-horse power a copper-wire of 127 mils diameter (No. 10½ B.W.G.) is equivalent to a water-pipe of $3\frac{7}{8}$in. diameter, or to an air-pipe of $3\frac{1}{8}$in. diameter, or to a wire-rope of $\frac{5}{16}$in. diameter. The proportion between the cost of these conductors, calculated for equal distances, is as 1·4 : 34·8 : 27·8 : 1. The conductor with hydraulic transmission costs, therefore, twenty-five times as much, and with pneumatic transmission it costs nearly twenty times as much, as with electric transmission. These figures prove that, as far as capital outlay is concerned, the electric system has the greatest advantage where the conductor is long—that is, where the energy has to be transmitted over a long distance.

It would, however, not be correct to compare the four systems on this basis alone. The comparison must be made on the question of capital outlay combined with efficiency: in other words, the figure of merit for each system is the price which has to be paid for one horse-power hour at the receiving station.

APPENDIX C.

EXTRACT from KNAPP on "ELECTRIC TRANSMISSION OF ENERGY," Pages 304, &c.

Comparative Estimates of Cost for Horse Traction and for Electric Traction.

HERR ZACHARIAS makes the following estimate as regards the cost of horse traction and electric traction. He assumes that each car is actually in use from five a.m. until one a.m.—that is, for a period of twenty hours per day—and that it requires a change of horses every four hours. This gives five pairs of horses per day per car.

A line worked by sixty cars would therefore require 600 horses actually in service, and, say, 10 per cent. more in reserve, or 660 horses in all.

To work the same line on the battery-system would require steam power up to 750-horse power, and a proportionate amount of electrical plant as given below. The capital outlay becomes :—

I. For Horse Traction,—	
Horses	£28,512
Harness and other gear	2,750
Total	31,262
II. For Electric Traction,—	
Steam-engines	£7,500
Boilers	4,000
Dynamos	2,800
140 sets of batteries	12,600
Cables and electric fittings	1,100
Motors and gear	6,000
Total	£34,000

Thus the first capital outlay is for electric traction only slightly greater than for horse traction, and if we consider that the buildings necessary to accommodate steam and dynamo machinery of a total power of 750 power-horse are not so extensive, and do not cover as much land as the buildings required to accommodate 660 horses, the balance in the first outlay may probably be in favour of electric traction. The working expenses are certainly much lower for electric. Herr Zacharias estimates as follows :—

I. Working Expenses with Horse Traction,—	
Depreciation per horse per day	0·4840 shillings.
Fodder	1·5720 "
Shoeing and attendance, per horse per day	0·1613 "
Total	2·2173 "
Total for 660 horses and 365 days	£26,707
Renewal and repair of harness	723
Total	£27,430
II. Working Expenses with Electric Traction,—	
Annual expenditure of energy, 6,570,000 horse-power hours.	
Coal	£6,570
Depreciation of batteries, 20 per cent.	2,520
Depreciation of motors, 20 per cent.	1,200
Depreciation of boilers, steam-engines, and dynamos, 10 per cent.	1,430
Repairs, oil, acid, wages	1,180
Total	£12,000

According to these estimates, the annual working expenses of electric traction on the Reckenzaun system would only be about half as great as with horse traction.

APPENDIX D.

REPORT by the Hon. the COMMISSIONER of TELEGRAPHS.

MR. ALLEN has sent me the enclosed letter, with three questions, as follows :—

Question.	*Answer.*
1. What would be the approximate cost of perfecting the Dunedin telephone system by means of return-wire, rendered necessary in case the single-trolly system is allowed the Dunedin Tramway Company?	1. It will cost about £10,000 to give each subscriber's wire a return-wire, and will involve new outfit complete at the Exchange on the multiple system.
2. Whether the return circuit would be necessary for the whole of the town, or only the portions where the tramways were running, and if a portion only of the town be completely circuited, what modification in cost would there be?	2. The earth of the Exchange, being contiguous to Princess Street, will involve the whole of the subscribers' circuits being made return.

3. Is there any modification of the telephone system, at a moderate cost, which, at the same time, would permit the Tramway Company to use the system they propose?

3. Under the circumstances, seeing that the Exchange earth is in close proximity, there is no modification that would be satisfactory.

I have answered these questions in their order, and would remark that if the concession is granted in Dunedin, it will doubtless involve Christchurch, Wellington, and Auckland, in the near future, which will mean reconstructing those Exchanges and wires, at an expense of quite £50,000, for we shall have to go underground with cables directly we adopt the twin-wire system.

It has been proved beyond a doubt that the double-trolly system is practicable. The telephone companies are now moving the British Parliament to give them a Bill to protect their interests as against the introduction of electrical tramways on the single-trolly system, and I have no doubt they will gain the day. I attach copies of articles out of one of my recent electrical papers which shows the aspect of the question, and I also attach copies of rulings by Judges in the United States, which go to prove that the double-trolly system is practicable, and is in full force and effect.

There is another aspect of the question that will have to be well considered. It is this: I am not quite sure, seeing the Telegraph uses the earth in Dunedin for its duplex circuits between there and Christchurch and Blenheim, that the introduction of the single-trolly system might seriously interfere with the duplex working, in which case, in order to give us the same wire accommodation as now exists by the use of duplex, would involve a further expenditure of £2,500 and £5,000 respectively, for duplicate wires between those places.

19th July, 1893. C. LEMON, Superintendent.

Enclosures.

[From the *News Letter* of the National Telephone Exchange Association, dated 30th June, 1890.]

THE Troy (N.Y.) *Press* of the 3rd June, 1890, has the following interesting article:—

A TELEPHONE VICTORY.—The Watervliet Company defeated in the Court of Appeals.—The Court of Appeals at Saratoga this morning handed down a decision dismissing the appeal in the case of the Hudson River Telephone Company against the Watervliet Turnpike and Railroad Company. The case grew out of an injunction issued by Justice Mayham, restraining the defendant from operating its road by electricity. An appeal to the general term was taken, and that tribunal sustained the injunction. The decision of the Court of Appeals is a practical confirmation of both decisions.

The litigation grew out of an injunction obtained by the Telephone Company restraining the Railroad Corporation from operating its electric line in Albany. The claim of the Telephone Company was, that a railroad operated by a single-trolly system would render telephone service difficult and unsatisfactory. It was asserted that if the double-trolly system was used, the difficulty with the telephone communication would be done away with.

The decision of the Court of Appeals will force the Railroad Company to use the double-trolly system, and it will affect other electric railroads and telephone companies.

At the inception of the litigation we suggested a compromise, the telephone and railroad companies to each pay half the cost of putting in double-trollys. This suggestion the Telephone Company was willing to follow, but the Railroad people would not listen to it. Now the latter will have to stand the entire expense of the change.

The decision of the Court of Appeals will be commended. On account of the operating of the Watervliet Railroad with single trollys in West Troy, and on the Albany Road, telephone communication with Albany has been difficult, and ofttimes impossible, for several months past. The introduction of the double trolly will give public convenience and safety.

[From the *News Letter* of the National Telephone Exchange Association, dated 28th February, 1890.]

AT Cincinnati, on the 12th February, 1890, Judge Taft decided the suit of the City and Suburban Telegraph Association against the Mount Auburn Electric Railroad Company, which case has been mentioned in a former number of the *News Letter*, and has attracted much attention all over the country.

The Telephone Company asked for an injunction restraining the defendants from using the single-trolly system, on the ground that such system interfered with the operation of telephone wires. The Court decided in favour of the Telephone Company, granting the injunction, but allowing the Street Railroad Company six months in which to make the necessary changes.

The opinion, which may be found in full in the *Electrical World* of the 1st March, 1890, contains the following paragraph:—

"The Court finds further, that there is a known mode of operating street-cars by electro-motive power by means of the double trolly, available to the defendant, the use of which will avoid and prevent the injury to the plaintiff above-mentioned. As a matter of law, the Court concludes that the defendant is bound to adopt some mode of propelling its cars other than the one which inflicts the said injury upon the plaintiff."

[From the *News Letter* of the National Telephone Exchange Association of 30th April, 1890.]

THE Italian Government has recently taken measures to protect telegraph and telephone lines against the harmful influences of electric-light systems and other industrial applications of electricity. In connection with this subject, the *Elektrotechnische Zeitschrift* gives the following particulars of the measures taken by the Italian Government:—

The lines used for electric lighting, or for other industrial objects, must form a closed metallic circuit, and having no earth contact throughout its length. It is forbidden to attach them to water- or gas-mains. The conductors of electric-light systems situated in the neighbourhood of a telegraph or telephone line must be covered with a substance impermeable to water, and sufficiently insuring

their insulation. In places where the working of the Telegraph or Telephone Administration would risk, in the course of their work, coming in contact with electric-light conductors, the latter must be provided with a special insulation, and placed far enough from the telegraph or telephone lines, so that a simultaneous contact with the wires of each other cannot take place. Immediate contacts between electric-light wires and those of the telegraphs and telephones must be absolutely impossible, either in the normal state of the wires, or in the event of a breakage of the wires. The lines must be constructed under such conditions of solidity that they are capable of resisting all the attacks to which they are likely to be exposed. In case of need they must be supported throughout their length by cables of suitable strength. It is necessary to avoid, as much as possible, the running of electric-light lines parallel with those of the telegraph and telephones. When a parallel course is inevitable, the electric-light lines must be kept at a distance of at least twelve metres from the telegraph and telephone systems. At the points of intersection, the electric-light wire must pass below and at right angles to the telegraph or telephone lines. The distance between the lowest telegraph or telephone conductors and the nearest electric-light wire must be at least two metres. The posts or supports of the electric-light conductors must be, at these crossing points, kept at a distance of at least three metres from the telegraph or telephone lines. In order that the latter shall not, in case of breakage, come in contact with the electric-light lines, a safety wire of sufficient strength must be placed immediately over each electric-light conductor throughout the whole of the crossing. Those establishing or working a system of electric lighting must take all the precautions of which science and experience have proved the utility. They must bring all their care to bear on the maintenance of their lines, which must be daily subjected to a minute inspection, and be kept constantly in a good state of repair. The constructor will be responsible for all damages and accidents caused by the system of electric lighting. The Government reserves to itself the right of altering or replacing the dispositions of the ordinance on which it acts, as well as of transferring or suppressing the electric-light lines if the contractor should not immediately execute the orders given him by the Administration, and that without any claim lying for indemnity. The telephone companies may demand the application of the latter disposition, as well as that relative to the distance of the electric-light conductors at the point where they cross the telephone lines, simply on condition of supplying proof that the proximity of the electric-light lines is hurtful to their telephone lines, which were established first. As far as regards the telephone lines which may be established afterwards, their owners must see themselves that they are placed at a suitable distance from the electric-light lines. When a contractor for the electric light wishes to have his lines transferred into the proximity of telegraph or telephone lines, or to introduce changes into an already existing line, he must for that purpose obtain the authority of the Telegraph Administration. The contractor will have to bear all the expenses resulting from the execution of measures of precaution or of transfer of telegraph, telephone, or electric-light lines. The Telegraph Administration itself may eventually execute these works at the contractor's expense. If the above dispositions be not applicable to certain particular cases, the Telegraph Administration reserves to itself the right of examining the propositions of those interested, and of approving them or rejecting them, as it deems most suitable.

Cheap Traction or Defective Telephones.

[From the *Electrical Review* of the 26th May, 1893.]

It is a great drawback to be too sensitive. The telephone suffers considerably by reason of its sensitive nature. Adopting for its own use a current of a very mild character, its utility is liable to be considerably impaired by interfering currents, such as those used for light or power. This interference may arise from induction, or from direct transfer of current. In consequence of this interference the Telephone Company has hitherto opposed all tramway proposals in Parliament or before the Board of Trade, with a view to the insertion of a protective clause, and has succeeded in many instances, but not uniformly, and—as the representatives of the Tramway Association inform us—not always on the merits of the case. Relying on its successes, however, and desiring to avoid the piecemeal method of procedure, the Telephone Company approached the Board of Trade with the view to the adoption of a standard clause for insertion in all future electric traction Bills and orders. To such a proceeding the electric traction interests naturally object, and the question is referred to a Joint Committee of Lords and Commons, which is "to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth-return circuits, or by any provisions as to leakage, induction, or similar matters, and if so, in what cases and under what conditions." The Joint Committee are to settle the necessary clauses, if they should arrive at the opinion that any prohibitions are necessary.

Messrs. Crompton, Garcke, and Morse have sent us a statement of the case as it is regarded by the Electric Traction Association, and this statement shows that the traction interests will not suffer from any lack of representation. The traction interests intend no longer to stand merely upon the defensive, their view of the question at issue being concisely expressed in the heading of their statement, which we have borrowed as a title to this article.

"The telephone system with earth-returns is 'admittedly defective.' It is this system which suffers from traction currents. Remedy this defect, and you will suffer no longer from traction," say, in effect, the traction interest to the Telephone Company. The neglect to take this course is regarded as prohibitive to electric traction, and it is urged with reason that traction must not be prohibited. On the other hand, there is the Telephone Company, with an established system, which may be rendered almost useless by the working of an electric tramway. Should a newcomer be given the power to render an existing system useless, or put the owners to very considerable expense to make it workable? Here is an issue which is a very suitable one for decision by an impartial tribunal, after full consideration of evidence.

We cannot regard the subject as one which involves only one set of conditions, and capable of being decided off-hand. There are, in fact, many matters of detail requiring settlement, and at least one novel element to consider. The electrical properties of the earth are likely to give rise to new readings of common rights. These electrical properties have been used for the purpose of transmitting signals of various kinds, telegraphic, telephonic, and railway signals. Have the users for these purposes, by virtue of priority, the right to monopolise the electrical properties of the earth in the same way that a first "squatter" may bring a portion of the surface of the earth within his "sphere of influence," and acquire exclusive rights by "annexation"? The electric utility of earth is common property; no exclusive rights can be allowed for it. It might be regarded as common land. But, on the other hand, is the enjoyment of such common land by peaceful users to be prevented by the proceedings of others, who use it in such a manner as to render it useless to the original occupants? These are one or two of the general considerations which arise on such a question. They will have to be considered in reference to the practical applications.

So far as telegraph lines are concerned, they are protected by "The Electric Lighting Act, 1888," which gives the Postmaster-General power to regulate the conditions on which any electric line or work may be used, so that it shall not injuriously affect any telegraphic line of the Postmaster-General, "or the telegraphic communication through any such line." The same Act protects other persons' lines, but not the communications through them. By this Act the Legislature has recognised the principle of protection for telegraphs belonging to the State, but has excluded telegraphs in private hands. Supposing that the State were to acquire the telephone system, there seems to be no doubt that under this Act the Postmaster-General could stop the working of all tramways which interfered with telephonic transmission. As the Post Office use metallic circuits for telephone lines, there is no doubt that any disturbance resulting from the use of earth circuits would only be temporary trouble under their *régime*, but in case of such temporary protection being necessary, it might be obtained in a summary way. The use of earth as a return for telephone lines may, we think, be regarded as only tentative, and those who desire to use the earth for traction may reasonably claim that the doubling of telephone lines should be accelerated in order that tramways should not be unreasonably delayed, supposing that the evidence should show that earth-working is a necessity for traction.

It is hardly likely that a solution of the question will be found upon the direct issue raised by the Traction Association. There should be some *viâ media* wherein the minimum of public inconvenience may be found. The developments of practical electricity may show it to be necessary to enforce as a general principle that each user shall keep his current within his own borders. In this way the earth will be only a means for the conveyance of leakage currents, and will not be a medium for directly connecting various sources of supply. The difficulties in the way of metallic-circuit tramways may, perhaps, be described as mechanical rather than electrical, they lay in collection rather than insulation. Whatever the reason, the use of an earth-return for traction is at present regarded as being due to something more than convenience or cheapness. This is an important practical point, and to it should be given due consideration; but it cannot be maintained that other modes of electric traction have yet been submitted to such practical tests, and have so far failed, as to make the earth-return the only method available. It is a subject within the scope of inventive ingenuity; and it is not wise to assume that finality has yet been reached. It will always be more easy to use one line than two; but when the use of one line causes disturbance to a neighbour, it may be necessary to show that two lines are impracticable, before permitting the use of one. The importance of electric traction cannot be over-rated. In all probability it will be a source of considerable employment to electricians, and a means of solving one of the difficulties of large cities that are growing larger. Rapid and cheap transit is a requirement of the times, and electricity will provide it. Its establishment should not be retarded by a too scrupulous regard for supposed rights, and should not be accelerated by failing to recognise one's duty to one's neighbour.

[From the *Electrical Review* of the 26th May, 1893.]

On April 26th, 1893, a meeting was held at the Board of Trade, Sir Courtenay Boyle, K.C.B., in the chair (Sir Joseph Warner, counsel to the Lord Chairman of Committees, being present), at which the Telephone Company and the Electric Traction Association were represented.

The Telephone Company put it to the Board of Trade that, inasmuch as during the past four years they had opposed some fifty Bills in Parliament, with the result that, with one or two unimportant exceptions, clauses for their protection had been invariably given, either in the form adopted in 1889 in the Lea Bridge case, or in 1890, in the Plymouth case, the time had now arrived when the Board of Trade should accept one of these clauses as a model clause, and take measures to insure the insertion of such clauses in all Electrical Traction Bills and Orders without further action on the part of the Telephone Company.

The essential portion of the Plymouth and Lea Bridge clauses is the first paragraph, as follows:

"1. The company shall so construct their electric circuits and other works of all descriptions, and shall so work their tramway in all respects, as to prevent any injurious interference by induction or otherwise with the electric circuits from time to time used, or intended to be used, by the Telephone Company for the purpose of telephonic communication, or with the currents in such circuits: Provided that, as regards electric circuits erected or laid down by the Telephone Company after the construction of the works of the company, this subsection shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such circuits, and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the company."

Sir Courtenay Boyle, having heard the representatives of the Traction Association, intimated that the Board of Trade were of opinion that what had taken place did not amount to the establishment of an uniform principle that there should be protective clauses in favour of the Telephone

Company. He thought that since 1889 a good deal of knowledge had been gained, and that the Board of Trade would now communicate with the authorities of Parliament to see whether the matter could be considered and settled, and that in the meantime the Board of Trade would not insert any protection clauses in favour of the Telephone Company.

As an outcome of these communications, a resolution for the appointment of a Joint Committee of Lords and Commons has been passed by Parliament "to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth-return circuits, or by any provisions as to leakage, induction, or similar matters, and, if so, in what cases and under what conditions." "And if the Joint Committee are of opinion that any such prohibition, restriction, or provision should be enforced, to settle the necessary clauses."

The question for consideration by the Joint Committee is in effect whether the Telephone Company is to have its present system protected or not. The form of reference does not at first seem to mean this, but it must be borne in mind that the Telephone Company are at present carrying on their business without statutory authority, and that (save by a general Act) Parliament can only legislate by the insertion of clauses into Bills or Orders brought before them by promoters asking for powers to use electric traction.

When this Joint Committee meets, it is assumed that the whole question of electrical traction and telephones will be considered, and the Committee will either give the Telephone Company the protection they ask, or say that any protection shall be conditional upon the Telephone Company amending or altering its system by the introduction of a metallic return or otherwise.

The Telephone Company allege that they have always obtained protection clauses from Parliament since they commenced opposition to those Bills in 1889.

This is not quite accurate. Out of fifty cases protective clauses were inserted in about forty cases by consent, given no doubt in many cases to save the heavy expense of a long Parliamentary fight; and it was only in about ten cases that the matter came before the Committee. In the cases fought, results were by no means uniformly favourable to the Telephone Company.

The evidence given by the Telephone Company may be summarised as follows:—

The Telephone Company first showed that the currents used by the Telephone Company were infinitesimal, and not likely to do harm to anybody else; that it was cheaper to them to dispense with a metallic return, and to take the current back by means of gas-pipes or otherwise by earth-returns. That telephones had been decided to be within the terms of the Telegraph Act, and that, in consequence, telephonic messages, being telegrams, were only a branch of a business which had been for 50 years carried on by mean of earth-returns, and therefore obtained a prescriptive right to the use of the earth. That the Electric Traction Company quite recently proposed to use earth-returns. That the currents required for electric traction were very large and powerful. That leakage from or the inductive effects of these currents passing interfered greatly with the telephones. That the Telephone Company's lines could be protected from interference by using a metallic return and twisting the wires. That such steps could, however, only be carried out at an enormous and prohibitive cost. That, on the other hand, it is very simple and inexpensive to prevent interference by insulating the conductors used for electrical traction.

The evidence upon which the Telephone Company have hitherto succeeded in obtaining protective clauses will show that the real facts of the case have never been fairly put forward, for it was to the folowing effect:—

That the same rules should be placed upon electric tramway cases that had been placed upon the electric lighting companies; that prevention of leakage to earth was solely a question of expense; that it was perfectly easy to insulate the two conductors in a conduit at an expense of about £40 per mile, whereas to lay down a metallic return to telephone wires would cost an enormous amount.

But electric traction cannot be governed by the rules placed upon electric light; for while nothing is easier than the insulation of electric-light conductors, from which the current is taken at fixed terminals, nothing is more difficult than the insulation of electric-traction conductors, where the current is taken by the arm of a passing tramcar.

In the Folkestone case, where the cost of insulating the tramway conductors was put at £40 per mile, the decision of the Committee was that if the Telephone Company required this done they must themselves pay for it; but the Telephone Company showed their faith in their witness's estimates by refusing the clause, and allowing the Bill to pass without any protection to them. As a consequence they had to pay the promoters' costs, amounting probably to more than the cost (on their estimate) of insulating the tramway conductors.

The telephone service with earth-returns is admittedly defective. The use of a metallic return by the Telephone Company is not only possible, but would, it is admitted, prevent all interference, and the only excuse given by the Telephone Company for their failure to make their system perfect by this means is that of expense.

On the other hand, it has been shown that the use of electricity as a motive power reduces greatly the necessary cost of tramways, but that in practice it is not possible to insulate the conductors.

The matter resolves itself into the question whether *cheap traction* is to be prohibited in order that a *defective telephone* system may be maintained, or whether the Telephone Company should not be compelled to perfect its system, and by that means take away the reproach that its service is not only bad, but retards the due progress of other electrical industries. And this is the real question that will have to be submitted to the Joint Committee.

Primâ facie it may seem that there can be little doubt that the decision will be in favour of the traction interest. But in view of the strong position occupied by the Telephone Company it behoves all corporations and local authorities, and all those who desire to see *cheap traction* encouraged and

the telephone service improved, to support in every possible way the Electrical Traction Association before the Joint Committee.

R. E. CROMPTON.
E. GARCKE.
SYDNEY MORSE.

APPENDIX E.

ELECTRIC RAILWAY *v.* TELEPHONE—DECISIONS in the SUPREME COURT of OHIO.

January Term, 1891: The Cincinnati Inclined Plane Railway Company, Plaintiff in error, against The City and Suburban Telegraph Association, Defendant in error.

Electric Street Railways—Single-Trolly Overhead System—Rights of Telephone Companies.

SYLLABUS.—1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and, in that view, new and improved modes of conveyance by street railways are by law authorised to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the rights of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city, prior to the operation of an electric railway thereon, will not give the telephone company, in the use of the streets, a right paramount to the easement of the public to adopt and use the best and most approved mode of travel thereon: and if the operation of the street railway by electricity as the motive power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of electro-motive power upon the street railway.

3. Where a telephone company, under authority derived from the statute, places its poles and wires in the streets of a municipality, and, in order to make a complete electric circuit for the transmission of telephonic messages, uses the earth, or what is known as the "ground circuit," for a return current of electricity, and where an electric street railway afterwards constructed on the same streets is operated with the "single-trolly overhead system"—so called—of which the ground-circuit is a constituent part, if the use of the ground-circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground-circuit as a part of the telephone system. (Decided Tuesday, June 2nd, 1891.)

But it is urged that the franchise of the telegraph association to construct lines of telephone is greatly impaired by reason of the single-trolly railway using a grounded circuit, whereby a large part of the electric current flows off from the rails to the surrounding earth, and to and upon all telephone wires which may be connected with the earth in proximity to the railway. The action is described as conduction, causing more or less of electric current to be poured into the earth and into all electric conductors connected with the earth, thereby reaching telephone wires in a grounded circuit, and creating loud and continuous noises upon the wires, which disturb telephonic communication. This disturbance, however, results not solely from the earth circuit of the railway company, but also from the fact that the defendant in error likewise relies upon the earth for its return circuit, by connecting with the earth the end of its wire furthest from its electric batteries.

It is claimed that, in addition to this conduction or leakage disturbance, the single-trolly electric railway introduces serious disturbances on telephone lines by induction, for the reason that such electric railways employ large wires to convey the current used for the propulsion of their cars, and this current is constantly and rapidly changing its strength; that these rapidly changing currents in the electric railway wires induce disturbing currents in parallel telephone wires near which the electric railways have been built, and thus prevent a successful transmission of telephonic messages.

This interferences with the telephone service may be obviated, it is stated, by the Railway Company giving up the single-trolly system with the ground circuit, and substituting a double-trolly system with its two trolly-wires, two trolly-wheels, and electric current passing from one wire through one trolly, through the motor, back through the other trolly to the other wire, and so back to the generator without escaping to the earth. The grounded circuit, it is insisted, should be abandoned, and surrendered to the sole use and service of the defendant in error. But it is admitted that other remedies of the telephone disturbances may be easily obtained by constructing the telephone with a complete metallic current, or by resort to what is known as the McClure device, consisting of a single return-wire, to which a number of telephone wires are attached.

Conceding that the mode adopted by the Railway Company of propelling its cars by electricity is an interruption to the telephone service of the defendant in error, and calculated to impair its franchise in the manner contended, the inquiry is suggested whether the Railway Company must yield up a useful franchise that the same may be exclusively enjoyed by the Telegraph Association, or whether the Association shall adapt its system to existing conditions; whether the Company shall change from the single to the double-trolly system, from the grounded to the metallic circuit; or whether the Association shall either use a complete metallic circuit or resort to the McClure device.

It is immaterial on which party the expense of the change may fall the more heavily. It is a question of legal right.

When the Telegraph Association erected its poles and lines in 1881 and 1882, with the design of conducting the business of the Telephone Company, it found the Railway Company operating its street railway, with authority under the statute to use other motive power than animals; to wit,

electricity, cable, or compressed air, upon obtaining the consent of the Board of Public Works. The telephone business was not among the probabilities when the streets of Cincinnati now made use of by the Telegraph Association were dedicated or condemned for the public use. The primary and dominant purpose of their establishment was to facilitate travel and transportation; they belong from side to side and end to end to the public, that the public may enjoy the right of travelling and transport of their goods over them. The telephone poles and wires and other appliances are not among the original and primary objects for which streets are opened, for they may be placed elsewhere than on the highways and yet accomplish their purpose. In Taggart *v.* Street Railway Company, 16 R.I., it was said (Durfee, C.J.,) that telephone poles and wires are not used to facilitate the use of the streets for travel and transportation: "Whereas the poles and wires of the Railway Company are directly ancillary to the use of the streets as such, in that they communicate the power by which the street-cars are propelled." As a general rule, an occupation of the streets otherwise than for travel and transportation is presumptively inferior and subservient to the dominant easement of the public for highway purposes, for if not so, the primary object of their dedication or appropriation might be largely defeated. And the fact that permission is granted to occupy the streets or highways for a purpose other than travel, does not confer a prior and paramount right to occupy them to the exclusion of their use for travel in a mode different from what obtained when such permission was given.

To those improved agencies, devised for the convenience and advantage of the community in general, the franchise of the Telephone Company to occupy the streets for carrying on its business must be secondary and subordinate. Whether all who go upon the streets shall have the most convenient and expeditious passage and carriage of persons and goods, has not been made dependent upon the manner in which the defendant in error has preferred to locate its poles, stretch its telephone wires, or form the electric circuit.

It is in recognition and maintenance of the superior easement of the public in the streets that City Councils are required to "cause the same to be kept open and in repair and free from nuisance"; that the streets are graded and paved and proper regulations of police provided to govern the actions of persons using them; that the abutting owner, though having a peculiar interest and easement in the adjacent street appendant to his lot, has no right to place permanent obstructions in the street, nor do any act on his own land outside the limits of the street that will make the way inconvenient or hazardous or less secure than it was left by the municipal authorities.

This paramount easement or estate which the public acquires in the streets carry with it a special interest in the adoption of the most approved systems of modern street travel, cannot be made subservient to the telegraph or telephone when admitted on the highway, without the clearest expression of the legislative will.

The demand made by the Telegraph Association is not that the Railway Company shall so modify its existing electrical apparatus as not to interfere with the telephone service, but shall for ever abandon the use of an essential part of its electro-motive system, or be perpetually enjoined. In other words, the Association claims the exclusive use of the grounded circuit, inasmuch as the mechanism of the telephone is so complex, and the electric currents employed so delicate and sensitive, that they cannot be used without disturbance from the heavier currents employed by neighbouring electrical enterprises that operate with the grounded circuit. We find no foundation for such an exclusive franchise or right.

When the Telegraph Association began its operations under the telephone system, neither the statute authorising it to erect and maintain poles, wires, and other necessary fixtures, nor the Ordinance under which it obtained the power to extend its lines in the streets, gave an exclusive right either to use the earth for a return circuit or a complete metallic circuit formed by double wires. The Legislature did not grant the right by general enactment, nor was the Municipal Corporation empowered by the Legislature to give the Telegraph Association the exclusive right to make use of its streets so as to create a monopoly.

It is contended, however, that the defendant in error, by virtue of its grants, acquired, before the Railway Company had a right to use electricity as a motive-power, a vested interest in the telephone system as it now operates it, with a grounded circuit, and that not even the Legislature of the State could take away from it or injure this franchise, on the faith of which it has expended its capital and labour. Special privileges or immunities are under the control of the Legislature. If granted, they may be altered, revoked, or repealed by the General Assembly (Article 1, section 2 of the Constitution). And while corporations with valuable franchises may be formed under general laws, all such laws may, from time to time, be altered or repealed (Constitution, Article 13, section 2). In view of these constitutional provisions, it is clearly within the power of the General Assembly to authorise one class of corporations to use, in the streets, electricity with the grounded circuit as a motive-power, and another class to employ the same or a similar agency for the transmission of telegraphic or telephonic messages. And, if the proper exercise of the rights granted to the one class under general law is irreconcilable and plainly interferes with a prior grant to a corporation of the other class, it may be construed as the intention of the Legislature to deny an exclusive franchise, if not to repeal the antecedent grant.

It is contended, however, in behalf of the defendant in error, that conceding the Railway Company and Telegraph Association to be upon an equal footing on the steets and highways in the enjoyment of their respective franchises, the company is bound to conform to the rule *sic utere tuo ut alienum non laedas*. In the view which we take of the relation to each other of the parties to the action, we deem it unnecessary to inquire whether there has been a want of conformity, and to what extent, if any, on the part of the Railway Company, to the requirements of the legal maxim. Nor do we think it necessary to determine how far an incorporated company making a lawful and careful use of its own property, or of a franchise granted to it by the proper municipal authorities, may be held liable for damages incidentally caused to another.

From the undisputed facts in the case, as disclosed in the records and printed arguments of counsel, it is evident, as we have already seen, that the Railway Company acquired from the State and from the City of Cincinnati authority to erect and maintain poles and wires in the streets or highways, and to use electricity as a motive-power for its cars. Clothed with such authority, we have, upon weighing the allegations in the original petition and applying to them the well-settled principles governing the legal rights of the public in the highways, reached the conclusion that the facts set forth in the petition are not sufficient to constitute a cause of action. We are of the opinion that there has been no invasion of the rights of the Telegraph Association by the plaintiff in error, and that the Telegraph Association is not entitled to the relief prayed for in its petition. The judgment, therefore, of the Superior Court at general and special term must be reversed and the original petition dismissed. Judgment accordingly.

APPENDIX F.

An Electric Tramway-Telephone Case.

In the High Court of Justice, Chancery Division, on the 4th February last, Mr. Justice Kekewich delivered judgment in the case of The National Telephone Company (Limited) *v.* Baker, which was one of momentous importance to telephone companies who had adopted in large towns the system known as the "telephone exchange," and also to tramway companies using electricity as the motive-power for their tram-cars. The action was brought by the plaintiff company, who are using their "exchange" system at Leeds, to restrain the nominal defendant—a contractor employed by the Thomson-Houston International Electric Company, who has recently constructed an electric tramway in Leeds which is under the control of the Corporation, from committing an alleged nuisance in the working of the tramway. The nuisance complained of was caused by electrical disturbance, the electric tram-cars affecting, it was said, the telephone wires to such an extent as to prevent the plaintiffs' subscribers from communicating with one another; and the question was whether the plaintiffs could prevent the defendant from causing this natural electrical disturbance to the prejudice of their telephonic system.

His Lordship, in an elaborate and exhaustive judgment, said that as between the National Telephone Company, whom he should treat as the sole plaintiffs, although another was associated with them, and the Leeds Corporation, whom he should treat as the real defendants, although not appearing on the record, there was no question of title, and no question but that each was lawfully exercising undoubted rights. Nor was there any question but that the acts of the defendants interfered with the exercise by the plaintiffs of their lawful rights; and the interference was of a serious character, so that, if actionable, the remedy would properly be by injunction rather than by damages. The real and only question in the case was whether the interference was actionable. It was practically admitted by the plaintiffs; and his own view certainly was that if they could maintain the action against the defendants at all, it must be on the application of the principle well known as that of Fletcher *v.* Rylands (L.R., 3 H.L., 380), and he failed to see any reason why the principle should not be applied to it. He could not see his way to holding that a man who had created, or, if that were inaccurate, called into special existence, an electric current for his own purposes, and who discharged it into the earth beyond his control, was not as responsible for damage which that current did to his neighbour as he would have been, if, instead, he had discharged a stream of water. The electric current might be more erratic than water, and it might be more difficult to calculate or to control its direction or force; but when once it was established that the particular current was the creation of, or owed its existence to, the defendant, and was discharged by him, his Lordship held that, if it found its way on to a neighbour's land, and there damaged the neighbour, the latter had a cause of action. Assuming the action to be maintainable, the defendants relied on two answers to the plaintiffs' claim. First, they said that the plaintiffs might, by an alteration of their system — that was, by the adoption of what was known as the "metallic return"—prevent the disturbance complained of; and, secondly, they said that they, the defendants, were acting under statutory powers, and that, if in the proper exercise of those powers they injured the plaintiffs they were free from blame. There was, no doubt, a body of evidence to show that a system different from that adopted by the plaintiffs had been adopted elsewhere with advantage, and might possibly prove to be the most convenient though more expensive for them; but the evidence also showed that their present system had been largely adopted and was received with favour by many competent to form an opinion. They were carrying on their own business lawfully, and in the mode which they deemed best, and he could not oblige them to change their system, because they might thereby possibly enable the defendants to conduct their business without the mischievous consequences now ensuing. Though the plaintiffs were under an obligation to obviate mischief from their own operations to their neighbours, they were under none, in his opinion, to protect themselves from the defendants or others. As to the second answer of the defendants to the plaintiffs' claim, his Lordship concluded that the plea was good in law, and that the defendants were not responsible to the plaintiffs for the mischief caused by their works. The defendants were expressly authorised to use electrical power, and the Legislature must be taken to have contemplated it, and to have condoned by anticipation any mischief arising from the reasonable use of such power. To the plea of statutory power the plaintiffs rejoined that such power could not avail the defendants, unless they had acted reasonably in the exercise thereof and had done their best to avoid injury to their neighbours. The argument being sound in law, one was compelled to examine the facts. The defendants worked their tramways on what was called the "single-trolly system." There were other systems which had from time to time been used, and, it seemed, were still in use elsewhere, and there were at least some good reasons for the conclusion that, by the adoption of one or other of these systems, the defendants

might wholly or partially avoid the mischief which they occasioned. There was a contest on the evidence whether any of these other systems could be regarded as good apart from comparison with that of the defendants; and there was a further conflict of evidence whether, if good, they were comparable in merit with that of the defendants. His conclusion from the evidence was that the defendants' system was, on the whole, the best which practical science had yet discovered; but there was no occasion really to go as far as this. It was enough to say—and about this he entertained no doubt—that it was at least as good as any other, and had been proved by experience, especially in the United States, where there had been larger opportunities for experiment and consideration, to be as likely as any other to meet the requirements of the traffic, and the convenience of all concerned in the protection of the site of tramways for the use of legitimate purposes other than those of the tramway undertaking. It could not be that in the application of the law which he was now considering the Court was bound to hold a railway or other company liable for the consequences of acts done under statutory powers, because it had not adopted the last inventions of ever-changing, ever-advancing scientific discovery. His Lordship held, on the above grounds, that the plaintiffs could not maintain an action, either from injunction or for damages, against the defendants.

APPENDIX G.

SIR,— General Post Office, Wellington, 1st September, 1893.

Herewith I beg to return my evidence taken before your Committee, and wish to point out the following remarks on the report of the Joint Committee of the House of Lords and the House of Commons, which I received last night (31st August) by the mail.

Taking sections 1 and 2 of that report, page 5, it appears to me, and in fact to any man who understands electrical science, that the proviso laid down there for the guidance of traction companies prohibits to a certain extent their employing uninsulated metallic returns for the use of the tramway, from the fact that the words "low resistance" in the above clause simply mean this, as I take it: that the resistance of the return conductor shall be equal, and not more, in its resistance to the outgoing; that is, from the dynamo through the overhead wire to the motor. And I base my conclusion on clause 8, subsection (*a.*), which states that "the return conductor if in contact with the ground shall be of such section and resistance as to have no difference of potential sufficient to set up injurious leakage currents in the earth." This I take to mean a large mass of metal placed between the rails so as to avoid anything like injurious leakage. I would point out to the Committee that, judging from clause 7, page 7, the House of Lords was evidently unaware at the time of making their report that the danger from fusion or electrolytic action was so serious as it has now been proved to be; and my premises are based on the fact that this report was ordered to be printed on the 13th July, 1893, and that the evidence of Professor Barrett, along with the photographs which I presented to the Committee at my examination, are dated Chicago, 1st July, and from that I draw the conclusion that the Committee could not have had in their possession that report and the photographs, otherwise the statement in clause 7 would have been considerably modified.

Whatever becomes of the question of insulated or uninsulated returns for the tramway, there is one consoling fact for the telephone companies at Home, and it is this, that no disturbance of the present system can take place until the undertakers of the tram section have given the companies two years' notice of their intention to lay tram-roads. This in itself, in my opinion, is a bar to all future operations, at any rate for two years, of any traction system in Great Britain, outside the lines and rules laid down by the report of the Committee in question.

I shall feel obliged by your having this printed, as no doubt this question involves large issues, amongst which, in this colony, would be the total destruction of the telephone system in the large centres as now obtains; and would mean that the Government of the day, in order to protect their system, will have to spend some £70,000 or £80,000 in putting their wires underground, and making twin circuits.

I may remark that, if that was all the difficulty that the department had to contend with, there might be some possible way of mitigating it; but, looking at the report of Professor Barrett upon the cables and pipes which have been destroyed by the electrolytic action of the current in Chicago, and other places, one cannot but come to the one conclusion, and that is this: that, whatever steps the Government of this colony may take to protect the interests of the telephone from the inductive or leakage effects from tramway currents, that nothing they can do will do away with the possibility of their cables in course of time being injured by the mere fact of the leakage currents taking hold of the armour of the cables in their passage back to their pole.

I mention these few facts, because I am aware this report will be read with considerable interest throughout the colony, and also by the House, and it is right that the public of New Zealand should have all the issues placed before them with the least possible delay, in order that they may arrive at a fair and just conclusion. It must be evident to any outside person, looking at the question from a colonial and political point of view, that no section of the community should be benefited at the expense of the taxpayer of the colony. In other words, in order to facilitate the passing of an Act to give the Tramway Company certain powers to erect their lines in the streets of Dunedin, that this colony as a whole should be called upon to spend some £80,000 in forwarding that interest, I think any impartial man, looking at it from that point of view, will say that the general taxpayer has a right to be considered in the first instance.

I have, &c.,

The Chairman, C. LEMON, Superintendent.
Public Petitions Committee (A to L), Wellington.

SIR,— 12th September, 1893.

In continuation of my letter of the 1st instant, covering my evidence taken before your Committee, I wish to point out that there is an impression abroad among some electrical engineers that by the reversal of the poles of the dynamo, that is to say, by putting the copper pole of the dynamo to earth and the zinc pole to line, the destruction caused by the corrosive action of the copper pole on the pipes and cables would be done away with, or mitigated to a certain extent. This conclusion is absolutely erroneous, and is not borne out by facts. It is a matter of no moment as regards the alteration of the poles, whether copper is to earth or zinc, so far as the question of avoiding the corrosive action by the copper pole is concerned.

In specimen 14 in the photograph which I left with you from the *Western Electrician*, it is clearly shown that the destruction of the coupling on the gas-pipe is, as Professor Barrett says, owing to reversal of street-car currents, and this reversal is due to the fact that some systems running in Chicago put their copper pole to earth, while other systems put their zinc pole to earth. This accounts for the corrosion on each side of the coupling.

It may be interesting to the Committee to know that the system of single trolly as now obtains is most wasteful in its expenditure of energy, for the reason that all the contact between the earth pole of the motor to its earth-return rails is made through the periphery of the tram-wheels, and that is an ever-varying resistance. Apart from the length of contact, which in a 22-inch wheel is about a quarter of an inch of flat surface, the dirt which is accumulated on the rails by crossing vehicles is itself a cause of ever-varying resistance between the periphery of the wheel and the rail. Since my former communication, I have been informed by letter from England that the Judge in the Leeds case said that his decision would have been given against the Tramway Company if the wires interfered with had belonged to Government. This remark is entirely applicable to the position which now obtains in this colony.

I have, &c.,

C. LEMON, Superintendent.

The Chairman, Public Petitions Committee (A to L), Wellington.

APPENDIX H.

REPORT FROM THE JOINT COMMITTEE OF THE HOUSE OF LORDS AND THE HOUSE OF COMMONS ON ELECTRIC POWERS (PROTECTIVE CLAUSES).

REPORT by the Select Committee appointed to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth-return currents, or by any provisions as to leakage, induction, or similar matters; and, if so, in what cases and under what conditions: And, if the Joint Committee are of opinion that any such prohibition, restriction, or provision should be enforced, to settle the necessary clauses.

ORDERED to report,—

That the Committee have met, and considered the subject referred to them, and beg leave to report:—

The Committee have taken evidence from Sir Courtenay Boyle, K.C.B., from Mr. Preece, Engineer-in-Chief and Electrician to the Post Office, and from Major Cardew, Electrical Adviser to the Board of Trade, and the Astronomer Royal.

Counsel appeared before them on behalf of: (1.) The National Telephone Company; (2.) The Railway Companies; (3.) Electric Tramway Companies, and Electric Underground Railway Companies; (4.) Electric Lighting Companies; (5.) Municipal Corporations, England and Scotland; (6.) Tramway Institute of Great Britain and Ireland; (7.) Gas and Water Companies.

Her Majesty's Postmaster-General was also represented, but not by counsel.

The Committee have heard all the witnesses tendered by the several parties, and have agreed upon the following clause, to be inserted in all Bills and provisional orders which authorise the undertakers, other than electric lighting undertakers, to use large electric currents, viz.:—

CLAUSE, to be inserted in all Bills and Provisional Orders which authorise any Company' Corporation, or Person, collectively referred to as "the Undertakers," to use large Electric Currents for other than Electric Lighting purposes.

(*Some modifications of form may be required to meet the circumstances of particular cases.*)

(1.) The undertakers shall, in the use of electric power under the provisions of this Act [order] employ either insulated returns or uninsulated metallic returns of low resistance. [This clause not to apply in the case of railways, tramways, or tram-roads in which the motive-power is entirely self-contained.]

(2.) The undertakers shall take all reasonable precautions in constructing, placing, and maintaining their electric lines and circuits, and other works of all descriptions, and also in working their undertaking so as not injuriously to affect, by fusion or electrolytic action, any gas- or water-pipes, or other metallic pipes, structures, or substances.

(3.) The exercise of the powers by this Act [order] conferred with respect tc the use of electric power, shall be subject to the regulations set forth in the Schedule to this Act [order], and to any regulations which may be added thereto or substituted therefor, respectively, by any order which the Board of Trade may, and which they are hereby empowered to make from time to time, as or when they may think fit, for regulating the employment of insulated returns or of uninsulated metallic returns of low resistance, for preventing fusion or injurious electrolytic action of or on gas-

or water-pipes, or other metallic pipes, structures, or substances, and for minimising, as far as is reasonably practicable, injurious interference with the electric wires, lines, and apparatus of other parties, and the currents therein, whether such lines do or do not use the earth as a return.

(4.) The undertakers using electric power contrary to the provisions of this Act [order], or to any of the regulations set forth in the Schedule to this Act [order], or to any regulation added thereto or substituted therefor by any order made by the Board of Trade under the authority of this Act [order], shall, for every such offence, be subject to a penalty not exceeding ten pounds, and also in the case of a continuing offence to a further penalty not exceeding five pounds for every day during which such offence continues after conviction thereof: Provided always that, whether any such penalty has been recovered or not, the Board of Trade, in case in their opinion the undertakers in the use of electric power under the authority of this Act [order] have made default in complying with the provisions of this Act [order], or with any of the regulations set forth in the Schedule to this Act [order], or with any regulation which may have been added thereto or substituted therefor as aforesaid, may by order direct the undertakers to cease to use electric power; and thereupon the undertakers shall cease to use electric power, and shall not again use the same, unless with the authority of the Board of Trade, and in every such case the Board of Trade shall make a special report to Parliament notifying the making of such order.

(5.) The undertakers shall take all reasonable and proper precautions in constructing, placing, and maintaining their electric lines, circuits, and other works of any description, and in using their electric lines, circuits, and other works, so as not injuriously to interfere with the working of any wire, line, or apparatus, from time to time used for the purpose of transmitting electric power, or of telegraphic, telephonic, or electric signalling communication, or the currents in such wire, line, or apparatus: Provided always that the undertakers shall be deemed to take all such reasonable and proper precautions as aforesaid, if and so long as they adopt and employ, at the option of the undertakers, either such insulated returns or such uninsulated metallic returns of low resistance, and such other means of preventing injurious interference with the electric wires, lines, and apparatus of other parties, and the currents therein, as the Board of Trade shall direct, and in giving such directions the Board shall have regard to the expense involved, and to the effect thereof upon the commercial prospects of the undertaking: Provided also that at the expiration of years from the passing of this Act [order] nothing in this subsection shall operate to give any right of action in respect of, or to protect any electric wires, lines, or apparatus, or the currents therein, unless in the construction, erection, maintaining, and working of such wires, lines, and apparatus, all reasonable and proper precautions, including the use of an insulated return, have been taken to prevent injurious interference therewith, and with the currents therein, by or from other electric currents. If any difference arises between the undertakers and any other party with respect to anything in this subsection contained, such difference shall, unless the parties otherwise agree, be determined by the Board of Trade, or at the option of the Board by an arbitrator to be appointed by the Board; and the costs of such determination shall be in the discretion of the Board, or of the arbitrator, as the case may be.

(6.) Nothing in this section shall apply to the use of any electric line, circuit, or work of any company, corporation, or person authorised by Act of Parliament, or provisional order confirmed by Parliament, to supply energy for electric lighting purposes, so far as such use is limited to such purposes.

The Committee have also agreed upon the following resolutions in the nature of recommendations, viz.:—

(1.) The Committee having regard to the evidence before them, are of opinion that it is not in present state of electrical science to the interest of the public to insist upon electrical tramways using an insulated return conductor, and that such insistance would retard the development of electric traction.

(2.) The chief objections which have been urged before the Committee to an uninsulated return conductor are: first, the interference by leakage and induction with telephones; secondly, the interference by leakage and induction with railway signals; thirdly, the damage to systems of gas- and water-pipes by the action of leakage currents.

(3.) They are of opinion that the best known means of overcoming the first of these disturbances is by providing an insulated return conductor for the telephones: and they have the less hesitation in recommending this course, as the evidence shows that telephone construction is already tending in this direction, and that better results are secured to the public by the use of a twisted metallic circuit insulated entirely from the earth.

(4.) The second objection deserves serious consideration on account of the danger to the public, but the Committee are of opinion that the disturbance may be remedied at comparatively small expense by the adoption of an insulated metallic return by the railway companies.

(5.) They consider that, although electric tramway and electric railway companies should be allowed to use the wheels of carriages and the rails to complete the electric circuit, the currents should be produced and used in such a manner as to mitigate, as far as is practicable, any injurious effect to telephonic communication.

(6.) The Committee are of opinion that it is desirable in every way to facilitate the use of complete insulated metallic circuits for telephones, and for this end they recommend that statutory powers be granted enabling telephone undertakers to lay their wires underground.

(7.) The danger from fusion or electrolytic action appears to the Committee to have arisen from a faulty system of constructing electric tramways, and they are of opinion that it can be reduced by improved methods of construction so as to be practically negligible.

(8.) The Committee therefore recommend that the Board of Trade shall, in virtue of the powers to be conferred upon them by each Act or Order, make regulations to secure the best system of working electric tramways and railways, having regard to the expense involved by the carrying-out

of such regulations, and to the effect thereof upon the commercial prospects of the undertaking. The regulations to provide, *inter alia*,—

(*a*.) That a return conductor, if in contact with the ground, shall be of such section and resistance as to have no difference of potential sufficient to set up injurious leakage currents in the earth.

(*b*.) That, both with regard to the structure of the line and to the method of generation and use of the electrical current, everything shall be maintained up to the standard required by the Board of Trade; but, if the regulations are altered after the use of electric power on the line has been sanctioned, the undertakers shall not be required to alter the structure or method of working of the line to conform to the more recent regulations, except for the public safety, or unless it shall be proved to the satisfaction of the Board of Trade that any system of metallic pipes or structures is being substantially injured by the action of electricity escaping from the conductors, or for purposes other than public safety or injury to pipes or structures which the Board may think right, provided that the alterations do not, in such last case, cause substantial additional expenditure.

(*c*.) That all such electrical tests shall be applied to the line by the undertakers as the Board of Trade may think necessary, and that a record of these tests shall be kept for the information of the Board of Trade.

(*d*.) That the Board of Trade shall have all reasonable facilities for making any tests they may think necessary, in addition to those recorded by the undertakers, to enable them to insure the maintenance of satisfactory conditions.

(9.) That the Committee regards with apprehension a large extension of the system of overhead wires in crowded centres.

(10.) It appears to the Committee to be just that undertakers proposing to use large currents should be required to give ample notice to those using small currents, to enable them to protect themselves by insulation, and that with this view, and in reference to the clause agreed upon, a period of two years may fairly be allowed to telephone and telegraph companies from the date of the passing of any Act [Order].

. . .

APPENDIX I.

Destruction of Telephone Cables by Electric Railway Currents.

[Extract from the *Western Electrician*, 1st July, 1893.]

City Electrician Barrett, of Chicago, has been gathering information upon the subject of the destruction of telephone cables by electric railway currents. The telephone companies in many cities have complained that their lines have been made inoperative by the establishment of railway lines, and their experience is given in the report which Professor Barrett placed before Mayor Harrison on Monday morning. This report, and the accompanying illustrations are presented herewith.

It has been found that many of the underground telephone cables are being destroyed in cities where the over-head single-trolly system of electric railways is in operation. Investigation shows that the heavy electric currents discharged by the electric railways follow the cables, using the cable sheaths as conductors.

A large number of potential measurements have been made, between the cables and the materials, which are in almost immediate contact with them, in order to determine the nature and direction of the currents. It has been found that these currents cause corrosion of the lead of the cable sheaths wherever such currents leave the cables and pass into moist earth, or into the surrounding moist walls of the ducts or of the manholes. In the cities examined, where underground telephone cables and single-trolly electric railways are in use, it has been determined that there are sections where the currents enter, and other sections where the currents leave the cables.

This destructive action of the electric currents is not alone confined to the property of the telephone companies, but extends to the water- and gas-pipes as well; in fact, to almost any buried metal-work. Such a condition of affairs must exist, to a greater or less degree, in all cities where the single-trolly system is in use, and it is probably only a question of time before the disastrous results will make themselves manifest. The appearance of some of the corroded cables and pipes is shown in the accompanying illustrations.

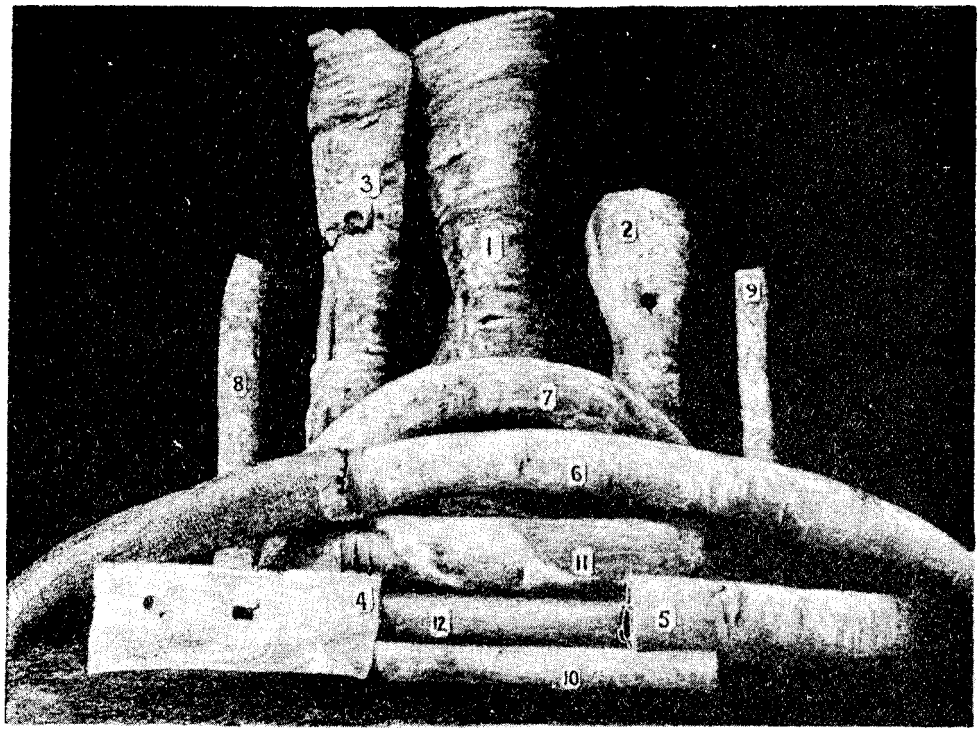
Specimens numbered from 1 to 6 were cut from telephone cables which were destroyed while in service by the electrolytic action, and had to be replaced. Specimen numbered 1 was from a taped cable, and the corrosion, as will be seen, was confined to the points where the moisture gained access to the lead between the lapped layers of the painted cotton tape. Number 2 is a characteristic specimen, and shows very well the pitting nature of these actions on lead. Specimen number 6 was taken from a cable protected by both tape and braid coverings saturated with tar or asphaltum varnish. The cable had only been in the ducts between three and four months. Directly above the label will be noticed a point where the corrosion had passed completely through the lead.

Specimen 7 shows the action of a current averaging 0·3 of an ampere, continued for two weeks on a piece of telephone cable buried in moist and clayey earth. The exposed area of lead was about one hundred and twenty square inches. A blank test, continued for three weeks, showed no signs of action on the lead by the soil.

Specimens number 11 and 12 are two pieces of cable which were placed together at the bottom of a manhole under precisely the same conditions, except that number 11 was connected by means of a wire to the sheath of a neighbouring telephone cable, while number 12 was not. After remaining underground for twenty days only, number 11 was found to be corroded.

Specimens number 8, 9, and 10 are pieces of lead pipe, and numbers 13 and 14 pieces of iron gas-pipe, which were destroyed by the street-car currents.

Specimen number 14 is especially interesting, as it shows very clearly what must often take place at points of high resistance in buried conductors. In this piece of gas-pipe the high resistance at the joint was probably due to the red-lead and oil used for the purpose of sealing. Owing to this resistance, a portion of the current which the pipe was carrying was shunted through the



Destruction of Telephone Cables by Electric Railway Currents.

surrounding moist earth, either to the coupling or to the section beyond, thereby causing the local destruction of the pipe. Corrosion occurred on both sides of the coupling, owing to reversals of street-car currents.

Specimen number 15 is a piece of iron gas-pipe which, while partially buried in moist clayey earth, was subjected to the action of a current of 0·3 of an ampere for two weeks.

When the action of the currents was first noticed, the experiment of grounding the cables to lead plates buried in manholes, was tried on quite an extensive scale, but was soon abandoned as being impracticable. The quantity of electricity to be dealt with was so enormous that the buried plates effected no appreciable protection to the cables. If such a system were feasible, the expense for the constant renewal of plates would be very large.

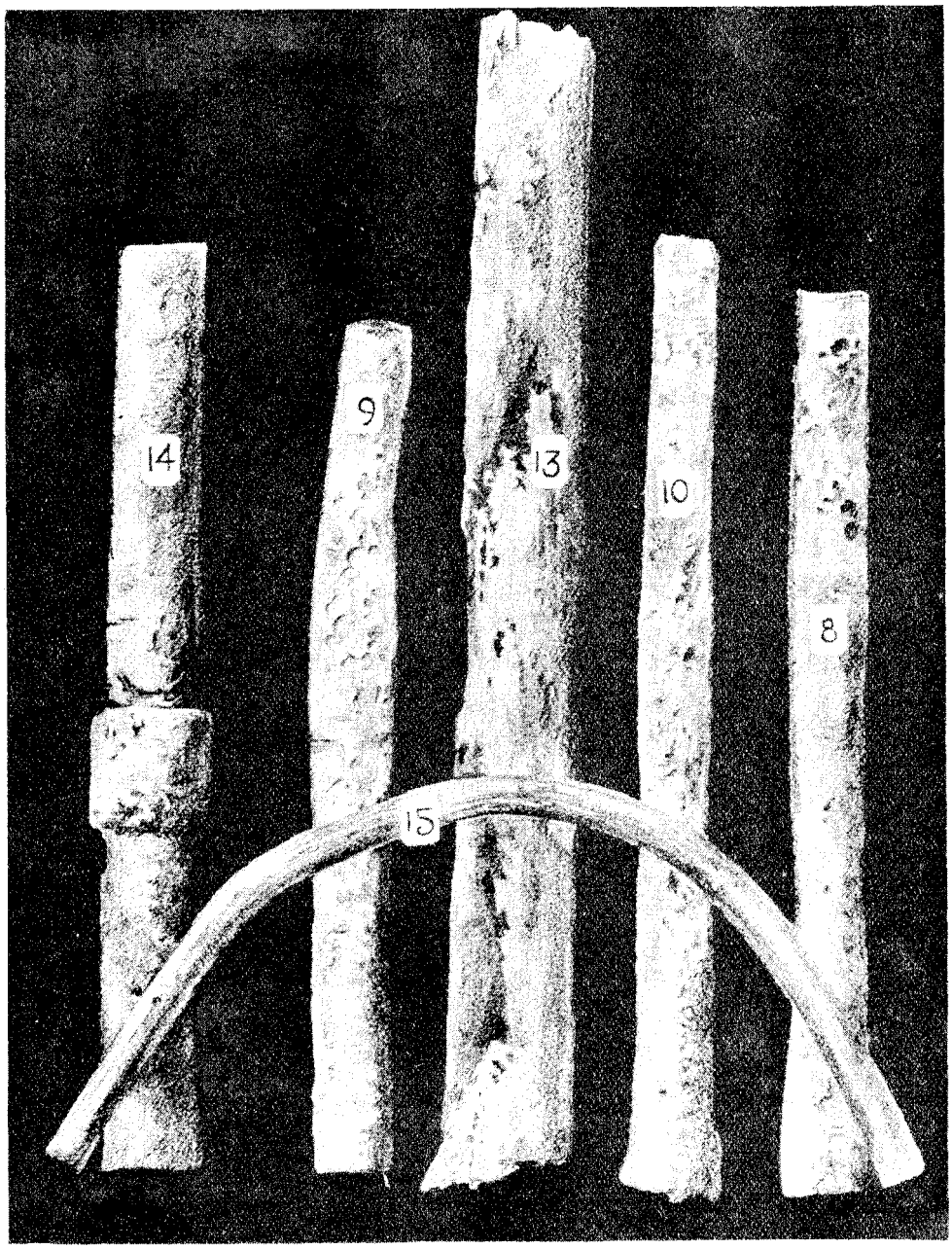
The severity of the action may be diminished to a certain limited extent by so arranging the direction of the current used for the street railways as to make it pass out over the trolly wires and back through the ground. In this way the direction of the current would be quite generally from the earth to the cables, thus diminishing in certain places the corrosive action. This method would not be a complete protection from the corrosive action, as there would be places where the current would still flow from the cables. Even though the current is uniformly to the earth from the cables, there is the possibility of an action caused by alkaline substances formed from a cable due to the decomposition by the current from the street cars of the soluble salts contained in the surrounding earth. These alkaline substances are capable, under certain conditions, of dissolving the lead when the currents are shut off or much reduced, as would be the case at night.

As there has been some misunderstanding in regard to the potential measurements made in connection with the numerous corrosion investigations, it should, perhaps, be impressed upon those who are about to carry on similar investigations, that the potential measurements between the cables or pipes and the materials surrounding them should, in the majority of cases, only be looked upon as indicating the direction in which the currents tends to flow.

To say that the pipes and cables are even practically safe from corrosion when the measurements are below a specified figure would be extremely misleading. These measurements are, in a certain sense, like the measurements which might be made in an electrolytic cell, between one of the electrodes and various portions of the electrolyte, so that it is possible to conceive of almost zero potentials in the immediate vicinity of the most violent electrolytic corrosive actions.

The fact should be clearly borne in mind that whenever we have a current passing from an easily oxidizable metal to the liquid, such as would be encountered in the earth, corrosion is bound to occur. A large number of electrolytic experiments have been carried out showing the extremely

test potentials (measurements between the electrodes) at which corrosion is found to take place. In many cases iron and lead were destroyed, under the conditions encountered in the underground systems, at potentials considerably under 0·5 volt.



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