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EVIDENCE TENDERED BY DR. BELL, OF UNITED STATES OF AMERICA, THE INVENTOR OF THE TELEPHONE.

PARLIAMENT HOUSE, MELBOURNE,
TUESDAY, 16TH AUGUST, 1910.

Members present:

Mr. W. H. WILKS, in the Chair;

Senator de Largie,
Mr. W. Webster.

Dr. Alexander Graham Bell, examined.

By the Chairman.—What is your opinion with regard to the stability of the telephonic art?—In the United States, we have passed through the experimental stage, and have now reached, I think, a condition of stability in the telephonic art. The company in America has been very generous in supplying the best equipment. Permanency means that maintenance and depreciation are very much less than when the art is passing through the experimental stage. I may say that I have not been connected with the telephone company in the United States for a great many years, and I am not a business man. Of course, I was the inventor of the telephone and the exchange system, but I cannot give you much valuable information on matters concerning details of business. I can only speak on general questions, and not on the commercial side. The published reports of the American Telephone and Telegraph Company will give you all the information you may require from the business side. On the question of rates I am not well informed.

Am I to understand that there has been very little improvement in the mechanical construction of the instrument itself since it was originally invented?—Yes, and that is a most remarkable thing. The telephone, as introduced is still used, although inventors have striven for the past thirty years to evade the patent, the same original telephone is used in what is called the receiving telephone. All the changes of importance have been in the instruments added on to the first telephone, consisting of two telephones and a wire. It is the intermediate equipment that has changed.

Has the equipment reached high-water mark?—There will be changes, but there are certain elements that have become established.

Is the common battery board in your opinion the most perfect system at present existing?—Yes.

Is it a system in which there are not likely to be many changes in the near future?—Changes are very unlikely. The common battery has been arrived at after years of experiment, and the expenditure of hundreds of thousands of dollars.

Is there any probability of a change that would revolutionize the plant?—Not for a very long time. Of course, I would not set a limit to the achievements of inventors. It may be necessary to remodel the whole plant by-and-by, but not materially for, say, the next twenty years.

Would you mind explaining why you desired to bring before the Commission the subject of the metallic circuit?—Because I have noticed in trying the telephones in Australia that you evidently do not have metallic circuits to a great extent. When I go to the telephone here, I hear what is known in America as "cross talk," which is due to the use of a single wire and earth circuit. In America they have gone through all that, and have replaced the whole of the single wires in the cities, not only

with the metallic circuit, but two wires twisted together. In fact, in America, what we mean by a central office, is a system of circuits, each composed of two wires, radiating from a central place. When I inquired into the proportion of metallic circuits in Australia I found that you have very few.

Without a metallic circuit, is it possible to get a highly-efficient service?—It is universally believed by experts that an efficient service cannot be obtained without the use of metallic circuits, the wires being twisted together, because there is nothing that we know of which will prevent induction. Effects can be propagated through empty space by induction, and the only way yet discovered by which the effect can be eliminated is by setting up an induction on one-half of the circuit equal to that on the other, so that they neutralize each other. When in large cities there are a multitude of wires coming close together, the effects of induction become so great as to destroy privacy, and the service is unsatisfactory. I unhesitatingly say a satisfactory service cannot be at present obtained without a metallic circuit, and direct and return wires twisted together. I saw some central exchange apparatus in Melbourne almost ready for use, which seems to be quite up to date, but is not yet in use, and I could not find out when it would be put into use. I am referring to the new switchboard in the new exchange. There is another question in relation to metallic circuits which is very important. In America the metallic circuits are put underground and aerial construction is avoided as much as possible. You have what appears to me some very fine conduits in Melbourne for underground work, and it would certainly be beneficial to the permanency of the system to place the wires underground, if possible. All sorts of disturbances are created by overhead wires. I remember in America when fires took place, in large cities the telephone wires would be cut down by the fire brigades, as the overhead wires interfered with their work. Then, again, a storm would disorganize the system, and the wires would get crossed. Then we had disturbances from high, potential electric light circuits and trolley wires, which completed the discomfiture. The majority of the wires are now underground. To get a satisfactory service it is imperative to have metallic circuits; and advisable to have an underground system, although it is expensive in the first instance.

I may say that you are corroborating what the members of this Commission have recommended in their report?—I am very glad to hear it.

For underground conduits, do you prefer iron piping or earthenware conduits?—That is a mere matter of detail upon which I hesitate to express an opinion. The main point is that it is very advisable if you want a permanent system to have the wires underground.

Do you consider that, although the initial cost of the conduit system is great, the outlay is more than recouped by the saving in maintenance and depreciation?—I am not competent to express an opinion upon that point. Undoubtedly the expenses for maintenance and depreciation are less when the wires are placed underground than in overhead circuits; they are of a more permanent and enduring character.

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Granting that the underground system is the better for the trunk lines, what about the household subscriber. Are his wires placed underground in America?—Yes, in the large cities there are no poles at all. The underground system goes right up to every building or block of buildings as far as possible. The more wires you can get underground the more permanent they are, and the less expensive to maintain; but I am not competent to speak upon the point as to whether the increased outlay required is more than recouped by the saving in maintenance and depreciation. There is undoubtedly a great saving, but as to what extent it would pay to underground them in Melbourne, I do not know.

Was the system of Mr. James brought under your notice?—Yes; I saw the remains of it yesterday, or the day before.

What is your opinion of Mr. James's method of undergrounding?—Any method, so long as it is good, is better than having the wires above ground. In the United States of America we have developed a special system of tunnels, of which I am not able to give a description. It is much better to have a tunnel into which a man can go than to have a small one if you can stand the expense. I saw the wire which had been laid down for twenty years under Mr. James's method, and it was as good as it was when first put in. I was very much surprised, as the wire was exposed to damp.

What is your opinion of the applicability of the automatic switchboard?—It is still in the experimental stage. Undoubtedly it will be developed in the future, but at the present time it has not proved satisfactory in any large exchange. We have quite a number of systems in the United States of America, but they have not yet been incorporated in a telephone system of any size. What you want in Australia is a standard system that has been developed, and of which you know all about. You could not do better than get the standard system we have in the United States. Means should be provided by which experimentalists could experiment on automatic systems. I think the automatic system is in the air, but it has not yet reached the practical stage, so as to be incorporated in our general telephone service.

Do you think the Government should provide an experimental laboratory?—It is very important that the Postal Department should have a laboratory to test all new ideas, and find out what is in them, and if good adopt them. An inventor may invent something which is all very well in a small exchange, but which has to be adapted to fit in with a large system; it is just one cog in a machine, and that cog has to be adapted. It is found in America that this work can be best done by having a scientific laboratory and a body of experts to test inventions. It is not only advisable to have a permanent system, but some means of improving that system. Government ownership places an obstacle in that direction, because it is the only buyer of new inventions. Therefore, it is more advisable under a Government system to have a testing laboratory and a staff of experts to test inventions, and give a sound opinion upon them than it would be in America, where there is competition. In America if one company does not test a new invention, an opposing company may do so. Without a Government laboratory it will be difficult to get improvements except from foreign nations; you would not get many Australian improvements; that is my opinion.

Did you see a selector invented by Mr. Godfrey, of the Railway Department, here?—Yes. I was very much interested in it; it is a very ingenious instrument, and works well on a set of twelve

stations. But it would require very much modification to adapt it to a telephone system. This is the case of an Australian inventor who should be encouraged in his endeavours.

Supposing that inventor devised an automatic system, how could it be tried?—In this country the Government has a monopoly, and the invention cannot be tried unless the Government gives the inventor an opportunity. All these new ideas require a great deal of adaptation before they can become commercially successful. We have a number of systems such as that of Mr. Godfrey in America on the step-by-step principle. I do not know that this one has any advantage over those of the United States of America except that it is an Australian production, which should give it an advantage in your eyes. You want a proper system of encouraging inventors and a department to test the value of inventions.

Do you consider that wireless telephony is likely to develop greatly in the future?—Yes, it is in use now in America experimentally, and speech has been transmitted 12 or 14 miles. When an invention begins in that way one cannot tell how far it will go. Wireless telephony is in the same stage as wireless telegraphy was some time ago, but it has not yet entered the field of practicability. In any case, it is unlikely to enter into competition with the present system of telephones on account of the difficulty of securing privacy.

Do you know anything about Pupin's induction spools?—Yes; they are very advisable on long-distance lines.

Do you think they would be suitable on the Melbourne to Sydney line, as employed in Germany?—I do not know how they are used in Germany, but in the United States of America they are being employed more and more on long-distance lines; they are not of much service on short lines, but on lines such as from New York to Chicago—1,000 miles long.

Do you think their application on the line between Melbourne, Sydney, and Brisbane would improve the working of the telephone?—Yes; I think undoubtedly that the use of Pupin's choking coils on these long services would improve them.

I may mention that the Commission has already made a recommendation regarding the use of Pupin's induction coil. Coming now to the traffic side of the telephone service, do you feel inclined to give an opinion on that subject?—I shall be very glad to give you any information I can.

Which is the more suitable; a telephone manager possessing a knowledge of traffic only, or a telephone manager with technical knowledge?—I think technical knowledge is necessary, and a business knowledge advisable. A telephone manager should have some technical knowledge to be in such a position.

Do the telephone companies in America have training shops for the training of fitters?—The instruments are manufactured by the Western Electric Company, and they have training shops. They make experimental apparatus as well as standard apparatus. Of course, we are anxious in the United States of America for a uniform service, and therefore we want standard instruments everywhere, and through the Western Electric Company we supply standard instruments to all our subscribers, as well as sell them to the public and competing companies. It is much better to have standard instruments connected than instruments not of a standard character. We look to the Western Electric Company to supply their own mechanics. There must be some special training of mechanics. You are in rather a backward condition in

that respect in Australia, from the fact that you do not manufacture your own instruments. If that were done it would be a very simple matter to supply the necessary training. I understand that your material is all imported.

Is it not essential for a good service to have an efficient body of trained men?—Yes. You must either have a manufactory where the men can be trained, or special technical schools; some technical training must be provided.

Do you prefer the measured rate to the flat rate system of charging for telephone services?—The measured rate is undoubtedly the more equitable means of distributing the burden of expense.

Would you distribute the burden of expense upon the average number of calls per subscriber?—I would rather say the average use that is made of the instrument by the subscriber. A subscriber benefits by the calls received as well as those sent, but you couldn't very well charge for calls received, though the only practical method is to charge by the number of calls sent. The trouble with the flat rate is that the burden of expense is not equitably distributed amongst the subscribers. If you distribute the cost equally among the subscribers it is obvious that the large users pay less, and the small users more than their proper share of the expense. The small users are always in the majority. Under the flat rate, therefore, the many suffer for the benefit of the few who use the telephone extensively.

Would you make the capital cost and working expenses the basis of the charge?—I think that is in substance the principle, but I am not a business man. I should think that the cost to be distributed should include interest on capital, the expenses of maintenance and reconstruction, and the working expenses.

Are you acquainted with the device known as the automatic recorder?—No; I am not familiar with the different instruments in use. We have all sorts of recorders in the United States of America. We have meters in the Central Exchange, and some in private houses, and nickel-in-the-slot machines at stations. I am not sufficiently familiar with any of these systems to make a recommendation, but there is one thing in relation to that subject which I think should be taken into consideration in such a country as Australia. The telephone is a means of annihilating distance and bringing people closer together, and in Australia it is supported by all of the people through appropriations of public money. For this reason we should extend the benefits of the telephone to as many people as possible. Now, the effect of the flat rate is to make people use the telephone on all sorts of occasions, and the telephone habit is formed. Well, from one point of view, that is what we want to do, but it restricts the number of subscribers to those who can afford to pay the flat rate demanded. Although the measured rate system is more equitable it tends to restrict the use of the telephone. When a subscriber is under the measured rate system, he begins to count the pennies, and he sends as few messages as possible, but this disadvantage is counterbalanced by the increased number of subscribers, for many more of the people can afford to come in on the measured rate plan than upon the flat-rate system. The measured rate restricts the use of the telephone. The flat rate restricts the users. There are advantages and disadvantages against both plans. It really does not matter to the Department or to the Government what method of payment is adopted, so long as the cost of the service is covered, with interest on the capital invested. The real parties interested

are the subscribers themselves; and the method of payment should be adjusted to suit the convenience of the public who use the telephone. Why not cut the Gordian knot by affording a choice. The only equitable distribution of the burden of cost that I can see is the measured rate, but many people prefer the flat rate; and if the small user likes to take that which is inequitable I do not think it makes much difference to the Government, so long as the flat rate is made sufficiently high to cover the maximum use that could be made of the instrument under unlimited conditions of service. If the users were given a choice between a high flat rate and a low measured service, matters would right themselves, and the public would perhaps be better satisfied to have a choice. Some subscribers make 100 calls a day, and if a flat rate charge were imposed which would cover 50 or 100 calls per day, the rate would be so high that few would care for this method of paying. But if the subscriber prefers this method, why not let him pay. The Telephone Department would not be a loser, if the charge is based, not on the average number of calls, but upon the maximum number of calls that would probably be made by a subscriber under unlimited service. I am pretty sure that in Australia if the telephone accounts were separated from the telegraph and postal accounts (as should be done by a proper business arrangement), it would be found that the telephone system in Australia is being run at a loss. The very first thing to do in fixing the rates is to find out what the system costs, and then distribute the burden of expense. I tried to find out in Sydney, but I found that telephonic matters were mixed up with telegraphic and postal matters, and it was impossible to separate the telephonic system from the rest of the service. When the cost of the system is ascertained, the basis is obtained for the calculation of rates. If the system is being run at a loss in Australia, how are you going to remedy it. It is obvious to me that the system cannot be run at a profit on the rates which are now charged, and it is very difficult to raise rates. From that point of view it is much better to have the rates too high than too low, as it is much easier to lower the rates afterwards than to raise them. The public are willing to pay a fair price for a fair service, but you can hardly expect to raise the present rates without much friction, unless you give a better service first. It seems to me that the efficiency of the system is the first consideration; and when you have a really efficient system and can give a good service, then comes the question of publicity. As our late President, Mr. Roosevelt, pointed out, the way to deal with monopolies is "to turn on the light." Our Telephone Company recognises that a great deal of its success has been due to its early adoption of "the policy of publicity," which has brought it into closer touch with the public. By convincing the public that the rates which were formerly considered extortionate only resulted in reasonable profits upon the large outlays necessary to produce an efficient service, the public have become better satisfied. A campaign of education has been carried on, and the American public have gradually become familiar with the nature and amount of the expenses incident to the service, and have been satisfied that the prices have not been artificially raised to pay dividends upon watered stock. Discontent at the charges became markedly less, with the result that the number of subscribers increased beyond all precedent in the history of the world. Americans are willing to pay a fair price for a fair service. If you have an efficient service, and the public are convinced that that ser-

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vice costs a certain amount, and that the rates must be raised, they would be better satisfied. A person goes up to a telephone instrument which costs only a few dollars to make, and he wants to know why he should pay so much for it. He has no knowledge of the complex machinery that has grown up in the central exchange, and the elaborate system of metallic circuits and underground wires. I think the first thing to do is to obtain an efficient service. It does not so much matter what the rates are if the service is efficient, for the people will be willing to pay a reasonable price for efficiency. I recommend your adoption of the policy of publicity, so that the public may understand the expenses involved, and realize that your rates are not extortionate.

Is it the American experience that it is better to take the people into your confidence?—Yes, and they wish to be assured of an efficient service at a fair price. In relation to the matter of efficiency in this country, you have three things to take into consideration: (1) The Government as represented by the Parliament which supplies the capital; (2) The Department to conduct the telephonic business; and (3) The public who use the telephone. Now in an inefficient service, in order to correct it, it is necessary to find out where the trouble lies. It may lie with the Government, it may lie with the Department, or it may lie with the public. As a matter of fact, as a general rule, it involves all three in different degrees. Now you must face the fact in Australia that your telephone service is unsatisfactory. There is no doubt about that. I have examined it to find out where the blame lay. I think it lies more with the Government than with the Department, in not providing up-to-date equipment, which involves the expenditure of a great deal of money. That is one element. Then there is another element; one portion of efficiency has reference to delays in completing a connexion. I examined into that matter, and had a little experience at Sydney. I had some observations made in the central exchange with the curious and significant result that the subscriber occupies in answering his telephone call four times as much time as it takes the central office staff to make the connexion. Therefore, delay is four-fifths due to the public, and only one-fifth due to the Department upon the average. The public can assist the Department very materially by promptly attending to their telephone calls. They do not realize that; and all the blame goes to the poor telephone girl, who does her very best. As the result of my inquiries I have come to the conclusion that the Department is giving as efficient a service as it can with the equipment at its disposal, and that the delays at the central exchange are not on the average very great. Of course, there are individual delays of the most aggravating description, but, on the whole, the average time taken to make a connexion is very short.

How long would you allow a telephone girl in a central exchange of 20,000 subscribers to make a connexion?—Is it too much to ask that one should not be impatient if she occupied a shorter time than it would take a person to hunt up a name in a directory. I made that experiment, and asked several people to hunt up words in a dictionary, and it took, on the average, twenty seconds. So if there is a delay of less than twenty seconds before the connexion is made in the central office, I do not think the telephone girls can be greatly blamed. Now the average time taken by the attendants in the Sydney Exchange came out at less than seven seconds, which showed me that there is no unnecessary delay there, and that the Depart-

ment is not at fault. The attendants are expert enough. Therefore, I came to the conclusion that the Department is not so much to blame for delays as the public themselves, who have formed the habit of not answering the telephone promptly. I think the efficiency of the Department is not so very bad, considering the conditions.

Are the telephone attendants in America male or female?—The telephonists are nearly all female in the central exchanges. We had to come to that. I remember very well when the telephone was first introduced, we had all young men in the telephonic service, and when it was about in the same condition as yours is now. The result was that the wires were kept "hot" with complaints. The young men in the central office would not stand that sort of thing, and matters became most uncomfortable. We put in a few girls in our central offices, and we soon noticed that, although there was just as much cause for aggravation, there were a less number of complaints. Women are nowhere held in higher respect than in America. If there is anything characteristically American it is the courtesy universally shown to women. When girls are employed as telephone operators, the average American will stand a great deal of annoyance rather than get the young lady at the other end of the line into trouble by making complaints, nor will he use language unfit for a lady's ear. The upshot was that we turned out all the young men and the telephone has opened up a new and great occupation for women, for which they are well adapted.

How many subscribers have you in America?—I do not know exactly, but the figures can be obtained from the American Telephone and Telegraph Company's reports, which are in Melbourne. In 1909 there were more than 5,000,000 subscribers.

Can you say what would be fair load for a telephonist in the central exchange?—I would be afraid to risk expressing an opinion on that matter.

Do you know whether the occupation of a telephonist is nerve-racking or injurious to females?—I have not heard of such a thing.

Have many complaints been made of that character in America?—I have heard of complaints of ear troubles. A girl through listening for long periods sometimes has an affection of the ear, which is sometimes attributed to the use of the telephone, although I doubt the justice of the charge. Quantitatively it does not amount to much. On the whole I do not think there is anything in the charge that the occupation is hurtful to women, at least in America. In Australia it may be different, for the young ladies in your central offices are brought into immediate contact with many impatient subscribers, who are apt to blame the central office operators for defects in the service for which they are in no way responsible, and the discipline of the office obliges them to bear unjust remarks in silence. There can be no more nerve-racking process than this. Young ladies are more sensitive than men, and it may well be that in some cases their lives are rendered miserable and their general health affected by the thoughtlessness of the general public in this respect. This is not, however, incidental in the nature of the business. It is a by-product of unsatisfactory conditions. Let the public generally treat the telephone girls with courtesy and consideration, and make their complaints in writing to the responsible authorities. The Department also could do much to remedy this condition of affairs by appointing some special person in each exchange to hear complaints. This is done in America, and the central office operator switches the dissatisfied subscriber on to the proper official, and is thus enabled

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to attend to her proper duties without being distracted by complaints. Protection from worry promotes the efficiency of the telephone girl herself. The Government also can do a great deal to relieve the situation by providing an up-to-date equipment. The complaints will then be less frequent, and the friction between the public and the Department materially reduced.

Are there telephone instruments inside cabinets in America?—We have sentry boxes all through the cities, but the public do not go into them. We generally have our public telephones in the stores. Public stations do not increase the telephone business on the whole so much as places where messages can be received as well as sent. The true way of ascertaining the value of a telephone is to ascertain the total number of calls answered and received.

How do they manage with incoming messages in the case where, say, Smith gets a call from Jones?—If it is Smith's store, and if he wants to call Jones, he puts a nickel (5 cents.) in the slot, or 10 cents, as the charge may be, and he can get Jones. If Jones calls Smith, Smith simply answers his telephone, and does not put anything in the slot at all, but Jones pays for it at the other end.

How is ventilation effectively provided for in the telephone cabinets of America?—I do not know. As I said, we have telephone boxes for policemen, but they are not used by the general public. The policeman opens the box with a key when he wants to make use of the telephone. I find that I have not understood your questions relating to telephone "cabinets." The expression is new to me. I thought you referred to locked boxes, closets, desks, or other cabinets too small to hold a man. I now see you refer to the telephone "booths" so commonly found in American hotels and other public places, in charge of an attendant. These are sound-proof closets with double glass doors, containing a desk and seat. They are only large enough to accommodate a man, and I don't think they are ventilated at all during use, but after a person leaves the booth the door stands open.

Have you paid any particular attention to wireless telegraphy?—No, I have chiefly confined myself to the telephone. I only have a general knowledge of the subject, and cannot speak as an expert.

The Commission was supplied some time ago with a comparative table of the telephone charges of the large cities of the world. Can you give us any information on that subject?—No, I can only direct your attention to the reports of the American Telephone and Telegraph Company. I would recommend those concerned to consult the reports for 1907-8-9.

Do you think the rates charged here are profitable?—When I said to a newspaper representative that I was astounded at the lowness of the rates in Australia, I had in view the half-penny per call alone, without taking into consideration the ground rent. Taking the ground rent into consideration the rates are not so very cheap, but you can judge better than I how they compare with the rates elsewhere. I may say that there is a principle of equity in your proposed new rates, but I am not competent to say whether they will cover the cost of the system. I suppose your ground rent is intended to cover the interest on capital, cost, maintenance, and depreciation. If that be so, it is an equitable principle, but the other expenses due to operation in the central exchange cannot be equitably divided among the users, unless it is distributed according to the use made of the telephone on the measured rate system. This is provided for on your half-penny rate. I think that in the proposed

rates your Government is going on the right principle; but if it is desired to extend the use of the telephone by increasing the number of subscribers, I think the ground rent should be as low as possible.

In Australia the average capital cost per subscriber of installing a telephone is £39. How does that compare with America?—My impression is that the cost is greater with us, but you are encroaching on ground of which I am not very sure. I may mention that one of the reasons for the great success of the telephone in America has been a very liberal appropriation for maintenance and depreciation. In 1909 we spent about 45 million dollars in maintenance and allowance for depreciation, all of which was taken from revenue. The principle has been adopted of paying for maintenance and reconstruction out of revenue. The total appropriation for maintenance and reconstruction for the last seven years is 231,500,000 dollars. The Australian Government cannot do better than make very liberal appropriation for maintenance and reconstruction. The main object to be attained is to keep up the standard of efficiency. Rates are comparatively unimportant as compared with efficiency of the service, because people will pay if they get a good service. Take as an illustration the fact that an instrument can be made that will talk pretty well from one part of Melbourne to another, but would not talk from here to Sydney. The instrument, however, that will talk from Sydney to Melbourne will talk equally well in the Melbourne network, and a liberal policy would dictate the installment of such an instrument for the local service. The policy of our Telephone Company is to install long-distance instruments everywhere, because the value of the telephone is in its connexion with other telephones, and the more telephones there are to connect with the more valuable each telephone becomes. If you instal an instrument only suited for a particular locality, then when the system is enlarged it becomes of no use, and the whole equipment of instruments must be changed. If the best service is established in the first instance, then it is ready for subscribers to take advantage of increased facilities. We have found in the United States of America that increased facilities creates a demand; and I am quite sure that the most important thing to do in Australia is to improve the efficiency of the service, and to provide as good an equipment as possible. The question of rates will take care of itself, if the public is taken into your confidence. If the service is not good, no matter how little the subscribers pay, it will not be satisfactory.

Is there any limit to the size of a workable network?—We have not reached it yet. It was my dream to bring people face to face in every part of the United States. That dream has come true, so far as the greater portion of the country from the Atlantic to the middle west, 15,000 miles or more, and is perfectly successful; there is only a gap between California and the middle west over the Rocky Mountains. That gap will be bridged in a few years, and then a man will be able to talk with any other in any part of the United States.

What in your opinion is the workable size of a switchboard?—That is a detail of construction. The whole system of central exchange connexion is a complicated matter. It will be undoubtedly changed by-and-by, but in the United States of America it now works so successfully that there is little likelihood of material change for a long time to come. The conditions here are similar now to what they were in America when we had the carbon

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transmitter, which was worked by a battery in each subscriber's house. Say there were 1,000 subscribers, then we had 1,000 batteries in 1,000 different places, where they could not be looked after. The introduction of the common battery in the central office was an enormous improvement over the large number of scattered small batteries.

By Mr. Webster.—Does the American system give practically a silent service?—Yes, in our best exchanges. Of course, we still have a good many grounded wires in rural districts, where there are not many wires to conflict with them. As a rule, in the best exchanges the service is a silent one.

Do you recommend the installation of an absolute metallic circuit system in the large centres of Australia?—Yes, it is imperative.

Would earth circuits in rural districts be sufficient?—A grounded circuit in a rural district would do very well for the district itself, so long as there were no other circuits near, but the moment such a circuit is connected with a central office exchange look out for trouble. It is better, on the principle of supplying the best service, to have metallic circuits even in rural districts, because it may be necessary to connect them with metallic circuit systems. The more expensive metallic circuit will prove the cheaper in the end.

Is there any system in use in America by means of which a number of subscribers on a single wire can be given a distinct service?—We have a number of systems of that kind. One of the features of the American Telegraph and Telephone Company is that it encourages experiments of that character. In Indiana, and some of the western States, where farmers' lines are established, they have quite a number of ingenious instruments of that sort, but nothing practical has come out of their use as applied to an exchange.

Is there any effective method in America to effectively prevent the transmission of a message to all the intervening subscribers on a single wire, and select the one for whom the message is intended?—We have a number of different ways of doing that on a small scale to, say, fifteen or twenty subscribers, but they are quite impracticable when you come to deal with a large exchange.

Would not such a system be of considerable use to subscribers situated in sparsely-populated districts?—Yes. Take the very promising little system of Mr. Godfrey, of Melbourne, who showed me his apparatus arranged for twelve stations. By means of his system one of the subscribers can be rung up without disturbing the others, but at every station there is an electro-magnet in the circuit, and therefore you have the impedance of all the twelve electro-magnets in the circuit all the while you are talking. If two such lines were put together it would multiply the impedance, as there would be twenty-four subscribers, and twenty-four electro-magnets would be constantly present, in addition to the two telephones used. Therefore, the system could not possibly be used for exchange purposes without modification.

Would such a system be of use in linking up rural subscribers?—Yes, I think it would.

When you were investigating that system, did you ask whether it could be extended to a larger number of subscribers than twelve?—I did not ask, because I saw that it could be extended very considerably, but you see that wherever it is extended, unless the principle is changed or modified, every extension involves putting another electro-magnet permanently into the circuit, that is another impedance, which impedes communication by putting in what is known as "resistance" in the circuit. Electrical resistance in the form of

a coil is much greater than that due to the same amount of wire straightened out on account of "self induction" in the coils of the electro-magnet.

To what extent could it be carried without detriment to the service?—It could not be carried to any very great extent, but I do not think there would be any difficulty in connecting twenty or thirty telephones.

Do you consider that a service regulated by an instrument of that character is far preferable to one that has no such regulator, on ordinary lines?—The system would be of very great advantage if it can be perfected and adapted to a system of telephones, but at present it is not adapted for use in a central exchange system. It could be adapted to a private line or a rural line not connected with an exchange, but would require a great deal of modification before it could be used for exchange purposes. Electrically it is good, but the principle is not novel.

Have you seen any instruments of the same kind in America?—We have a large number of such systems, most of them on paper, worked on the step-by-step system. The principle is correct, and no doubt will be developed. When I looked at the local instrument here, it did not strike me as being very novel. I think you will find that a great number of inventors have substantially the same idea. The thing that pleased me was to see an Australian working at it, and I do not wish to discourage him. The brains are there, and the system should be developed.

Did you form the opinion that Australia has not yet passed out of the infant stage?—I am of opinion that the laws in Australia are not favorable to inventors. You seem to base your patent law on the English model, which is not favorable to inventors. In America no patent is granted to any other man than the first inventor, and then only after an examination has been made by the officials of the patent office to find out whether the supposed inventor was really the first inventor of the matter claimed. A man never knows whether he is the first to invent any instrument. He may know that the invention was original with himself, but does not know what others have done. The same thing may have been invented before he was born; therefore, the patent office makes an investigation to find that out, and only if he is the first inventor will he be given a patent. When I investigated the patent system of England some thirty years ago, I found that a man, whether the inventor or not, could obtain a patent for almost anything he chose, if he paid the fees, and after getting the patent it was not worth much in the way of protection, for the onus of proof that you were the first inventor was thrown upon you. You would have to prove to the satisfaction of the Court that you were the first inventor before your patent was of much avail. No patent was of value until it had passed through a lawsuit—an expensive process. In America, the patent granted by the patent office is held by a Court of law as *prima facie* evidence that you are the first inventor, and the burden of proof that you are not is thrown on the other side. The result of the American patent law can be seen in the stimulus which it gives to inventors. I am both British and American. I was a young man when I left Great Britain, and have been in America for about forty years. I am pretty sure that the telephone invented by me would not have been developed in England on account of unfavorable surroundings. Not only do the patent laws of America afford protection to inventors, but

APPENDIX XXXIX.—*continued.*

the social environment is favorable to the growth of new ideas. In Great Britain the attitude of the general public towards a new idea seems to be: "This is a new-fangled notion, let some one else try it first, and we can then see how it works." In America the attitude is: "This is a new thing, and therefore probably better than the old; let us try it." That attitude is typical, and stimulates invention. It would be to the interests of Australia to stimulate invention, and protect inventors in the ownership of their creations. One of the great dangers in a country like Australia is that Government ownership is going to interfere with the improvements of inventors by stopping the financial rewards that are before them. One way to improve your telephone system would be to stimulate invention; and your Telephone Department should have a Board of Experts to take up new ideas, try them, and advise the Government on them.

Do you think it would be advisable if the Government itself were to offer such incentive that would induce young men to exercise their brains in the direction of invention?—I think such would certainly be an advantage. If you could show in your telephone system the direction in which improvement is wanted it would be a great advantage. For example, for thirty years people have been trying to improve the telephone instrument itself, but it has not been changed. It is no use their setting inventors to work to try and do that, because it has not been done under the stimulus of thirty years' competition. We have a complicated mass of instrumentalities for connecting the telephones together; there it would pay to set inventors to work to simplify the system. I have some facts collected in Melbourne and Sydney, showing the average number of calls made by subscribers to be only about four per day. Even in America the average is only six calls a day, so that each line on the average is used for only about half-an-hour out of the twenty-four hours, lying idle the rest of the time. How to utilize that great waste is the point. That is one of the things to which the attention of inventors might be directed. Then, again, if you examine your central exchange, you find that only a small fraction, say, 10 per cent. of the circuits, are in use at any one time, so that 10 per cent. of the circuits would do the whole business if you could only shift them to the subscribers as wanted. There is a great field for invention. Now, just a little indication to show what an inventor might do. Suppose you take a cable of wires into a man's house instead of a single wire, it can be easily seen that if one line is busy you could give him another; he could have a choice of wires in that way. By multiplying the wires to the subscribers' houses you might actually diminish the wires required for the whole system, because a cable could be carried from one house to another without going back to the central exchange. All sorts of schemes might be evolved for simplifying matters. You might have special calling and talking circuits. You might have certain circuits for no other purpose than talking, and thus get rid of impedance. If you have a telephone at each end of a circuit, and nothing between, you would get rid of all sorts of trouble. In any organism the important thing is the specialization of functions, just as in the human body. You have organs in the human body set apart for certain purposes—the eye for seeing, the ear for hearing, &c. So in a telephone system you get specialization of functions. When the telephone receiver was first invented it was a jack-of-all-trades invention, being

transmitter, and receiver, and call-bell all in one. Both telephones were employed, and a push-knob worked a lever that hammered against the edge of the diaphragm, producing a sound at the other end like a knock on the door. The first step in specialization was the development of the magneto call-bell used specially for calling purposes. Then came the carbon transmitter, specialized for talking purposes. The original telephone is now used only as a receiver, but it has not yet been specialized for hearing purposes. It still retains vestigial organs, indicating its line of evolution. For example, you have a mouthpiece on the receiver which is never put to the mouth, but only the ear, a relic of the days when the instrument was transmitter and receiver in one. You would hear better by omitting the mouthpiece, and putting the ear directly against the diaphragm, but the diaphragm is so thin that the pressure of the ear would cause it to come into contact with the pole of the magnet. But this thinness is a relic of its transmitter days, so that it should be easily vibrated by the voice of a speaker. A thin diaphragm is not specially advisable in an instrument used only as a receiver. It could be thickened with advantage.

Do you think there is still much room for specialization?—Yes, especially in the utilization of wires which are used only for a few minutes a day; to find some means whereby that wire can be made use of for other people; to utilize wires to the full extent instead of one-tenth, or one-twentieth, of their capacity. There are vast fields open in that direction which require to be pointed out. The wires are sufficient to carry one hundred times more business if they were fully utilized, and that is the direction in which invention should be stimulated in the future.

If a material improvement were made would it not involve to a very great extent the reconstruction of the service?—It might, and that matter has to be taken into account. In my opinion there will be very great changes when inventors have focussed their energies upon the weak points of our present telephone system, but it will take a long time to develop and introduce them. You are safe, I think, for the next twenty years, but in Australia you are prolonging the period of change. You have some up-to-date appliances, but it is going to take a long time to introduce them. A portion of the system is obsolete, while another portion is up-to-date. The shorter the period of change can be made the better. The trouble is that if one portion is magneto and another the common battery system; you cannot get satisfaction. If you were to sweep out the obsolete material and to put in what is up-to-date, it would last a very great number of years. The process of transition should be as short as possible.

Do you think it possible to give anything like a perfect service in an exchange such as that at Sydney?—I do not think so. I think the Department is doing as well as it can with the equipment, and outside of the equipment it is reasonably efficient.

What would you call a reasonable service as compared with that in America?—We get better effects; we get silence in the circuits; we get privacy of communication; we know no other people on other lines can hear what we are saying. A very important factor is promptness of connexion, and in that direction I do not think the Sydney Exchange is much to be blamed. An average of several hundred connexions only took seven seconds each.

How would an American subscriber look upon a service such as you have experienced in Australia?—He would not tolerate it; he would not pay for it.

APPENDIX XXXIX.—continued.

Not at any price?—I do not think so. Just listen to the cross-talk and disturbing noises in a telephone in Melbourne; it would not be tolerated for a moment in America. It is not the fault of the Department; it is doing as well as it can with the equipment. They should be given metallic circuits to get rid of disturbing influences.

Is there any other system of metallic circuits in use than the twisted wire?—I do not think so. A metallic circuit of any kind will materially reduce the disturbances, but unless the wires are twisted together the disturbances may not be completely extinguished. On long distance lines, the disturbances are reduced or extinguished by altering the position of the wires on the poles so as to make them twist round one another many times in the course of a mile. There is no expert in the world who would not recommend metallic circuits and twisted wires.

Is it essential for an effective service that all connexions should be metallic circuit on a common battery board?—I am not so sure of that, but I think it would be so. Common battery boards are fitted for that special purpose. It would be very difficult to connect together metallic circuit systems with systems that are not metallic systems. You have to introduce an induction coil to transfer the current from the one circuit to the other.

Am I to take it that the whole of the connexion would be better if metallic circuit?—Yes.

Can you give the Commission any information regarding the hours of employes in the telephone exchanges in America?—I presume they work a little longer than they do in Australia. I know your busy hours are just the same as those in America—from 11 to 12 noon, and from 1 p.m. to about 3 p.m. We have a plan of putting on an extra staff at the busy times, as we know so well when we expect the busy times. I have some very interesting diagrams showing the amount of business done at various hours—[diagrams exhibited].—It might be advisable if you could offer special facilities for people to use the wires at other than the busiest hours.

Could you suggest a method whereby such inducement could be offered?—Yes, a different rate within certain hours. I think there is something in that idea. The busy time is known very well, and the business is congested within a very few hours. At night special rates might be given to the press, and you might allow people during such hours to make use of the telephone at a cheaper rate. Such a method might tend to flatten out the curve I have exhibited.

Has any such system been adopted elsewhere?—I do not know. The idea only really came to me on examining the graphical curves (curves exhibited which showed that the great volume of business was concentrated within a very few hours). If subscribers could be stimulated to make use of the telephone during the slack hours, it would be something worth consideration.

Could you say whether the telephonists work more strenuously in America than in Australia?—When I go into a central exchange in the United States I am struck with the quietness existing, but when I go into a telephone exchange in Australia I hear a good deal more noise. When we had men telephone attendants in America it was a perfect terror in the central exchange. It is remarkable to see 100 or 150 young women, and hear such little noise. They are disciplined in that respect, and are taught to speak almost in a whisper into their transmitters. You do not have very much noise in the exchanges in Australia, but you have more than in the United States.

How does the design of the Australian exchanges compare with those in America?—They do not compare at all; ours are so enormously superior, and facilities are given to the girls in the shape of retiring rooms, &c. Besides, we have fireproof buildings all through, which is very important. A fire might disorganize the whole service.

Are the wires preserved from the time they enter the building?—They are all in a fire-proof building.

From the time they leave the conduit, are they practically safe from fire?—Yes.

Are the Australian exchanges defective in that way?—You have a regular death-trap at one of your exchanges, at Windsor. You have a large exchange practically in a room 18 or 20 feet long, crowded with girls, who have hardly room to move about. That is an awful condition of affairs. The building is wooden, at least in part, and everything is of a make-shift description, whoever is responsible for it. If I remember rightly, at that same place, there is a new building with modern up-to-date equipment; but they are not in it; and I could not find out when are going into it. They are practically ready to occupy it; but it looks as though the trouble were at this end of the line (Parliament), want of the necessary appropriation, or something of that sort. The Windsor exchange is dangerous, as well as inconvenient.

Would you regard the Sydney Central Exchange as a safe place for the employment of a large number of people, in the event of fire?—It is not very safe, when you consider that telephone wires are liable to be struck by lightning. We often have "blazes" in our central exchanges in the United States, America. The electrical discharges are carried into the central office; but I do not know of any person being killed in that way. The fires do not occur in the building, but in the switch-board. We also have fires caused by connexion with aerial electrical light wires, which carry a current of high potential, and which is worse than lightning. Lightning is instantaneous, and you can prevent its evil effects; but the accidental crossing of an electric light wire may start a fire in a private house, at the telephone, in a very insidious way, which may not be discovered until too late. The undergrounding of the telephone wires escapes all those troubles.

How did the Sydney Exchange strike you, as compared with the American exchanges in regard to ventilation, light, hygienic conditions?—I do not know it would be quite right for me to express an opinion on that point. I was not particularly favorably impressed with the hygienic conditions; but I do not know that they are very bad. I do not find any special fault with the Sydney and Melbourne Exchanges in that respect.

What is your opinion of the Brisbane Exchange?—I think the Sydney Exchange is a little better.

Do you think they could be improved from the hygienic point of view?—Yes. We are ahead of you there. I do not desire to criticise the hygienic conditions existing in your telephone exchanges; but we have better conditions in America. The impression made upon my mind was that we have the interest of our telephone girls more at heart than you have in Australia. I may be entirely wrong in making such a generalization; but we have all sorts of conveniences for the girls, such as retiring rooms, &c. I know it has been a policy of the company to look after the welfare of the Central Office operators as an element in increasing the efficiency of the service. They cannot do their best work if discontented and worried. Whatever the cause may be, an impression is left in my mind that there is

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more done in that way in America for the convenience and good of the operators than is done in Australia. The conditions existing at Windsor are, I should think, unknown in the world. I have not heard of anything like it. I hope you gentlemen will try and discover the cause of the delay in relieving the congestion there, and remedy matters. It is a pity that these girls should be in that building a moment longer than necessary.

Are restaurants provided for telephone girls in America?—There is a great deal done in some of the cities in America, and I know they have lunches provided; but I am not familiar with the details. I do not know whether there are special restaurants. I have said there are retiring rooms, and places where girls can go and lie down on a couch. That is a very kind thing to do, because a girl requires to lie down occasionally more than a man does.

Would such action reflect itself on the service rendered?—Yes; but I do not say you treat your attendants badly. The principle, however, is sound, that, by providing the comfort for the attendants you will promote the efficiency of their service.

Do you know anything of the conditions existing outside America?—No. As a general rule, I have kept as far away from the telephone as possible; but I have been unable to escape in Australia, on account of my desire to know what you are doing on this side of the world, and on account of the kind interest shown in my visit by this Commission. It would gratify me very much should my evidence be of help to the people of Australia in settling their telephone difficulties.

Do you think it would be a good policy for the Australian Government to send some of its experts to other countries from time to time to inform themselves as to what advances had been made in telephony and telegraphy?—Such a policy would be very important, and for the good of the service in Australia. I know that your electrical expert, Mr. Hesketh, has already been sent to America; and I find him quite well-informed as to what we are doing there.

Does the telephone company in America rely on America alone for its advances?—No. We have a bureau of experts for research; and it is their duty to see what is done elsewhere, and also to try new ideas.

Do those experts travel?—Some of them do. Then there are annual conventions of persons engaged in telephonic work—telephone associations—and methods are discussed, and a great deal is done to ascertain what is taking place in the rest of the world. The experts of one company can exchange views with the experts of another in America, and increase their knowledge thereby.

Would it not then be more important, in the case of Australia, to send experts abroad?—Certainly.

Do you think we are losing a great deal thereby?—Undoubtedly. Of course, you should send your experts to the United States, America, where the telephone service is at least equal to any in the world.

By Senator De Largie.—Are all the telephone services in the United States of America in the hands of private companies?—Yes.

Does one private company control the whole of the United States of America telephone service?—There is a system of affiliated companies. Suppose you put the Commonwealth Government in the place of the American Telephone and Telegraph Company, and the State Governments, or municipal bodies, in place of the associated operating companies. Now the American Telephone and Telegraph Company does an inter-State, or rather an

inter-exchange business, owning and operating the trunk lines connecting the exchanges. The exchanges themselves are owned and operated by the local associated companies. The policy has been adopted of enlisting local capital and local control by persons familiar with local conditions, the American Telephone and Telegraph Company aiding in providing the capital required by purchasing stock of the operating companies. It also controls the general policy of the associated companies, defends them, and through the Western Electric supplies them with standard apparatus—securing uniformity of equipment—and inter-dependent conditions over the whole country. There are also many independent telephone companies which connect with this system by special arrangements.

What is the name of the central company?—The American Telephone and Telegraph Company.

Is there not a large company bearing your name?—The American Telephone and Telegraph Company, together with the associated operating companies constitute what is known as "the Bell System." If I remember rightly there are about 5,000 local operating companies in the Bell System, with the American Telephone and Telegraph Company as an organizing and controlling centre.

Can you give the Commission an approximate idea of the amount of capital invested in telephone companies in America?—The amount is almost inconceivable. If I remember rightly, the amount of capital invested in what is known as "the Bell System," is something like 650,000,000 dollars, and is extending rapidly all the time—[*diagrams exhibited*].—These diagrams show between 5,000,000 and 6,000,000 subscribers' stations in 1900. The connexions per annum number billions. This refers to the Bell system alone, and does not include the independent telephone companies of America. I suppose that the business of the telephone companies in America equals, if it does not exceed, the rest of the world, it certainly greatly exceeds the whole of Europe.

How do you think the electrical engineers in Australia compare with those in America?—I have been very favorably impressed with the few electrical engineers I have come into contact with in Australia. I think that Australia is to be congratulated in possessing such men.

Do you think they have made the most of their opportunities with the capital supplied them?—I do. I feel that a great deal of the unsatisfactory work done is due to the lack of equipment. So far as the handling of the business is concerned, I do not think they could do very much better with the equipment.

If I were to say that the greater portion of the evidence taken by this Commission shows that the Department has been starved through want of funds, would I be right?—I should say so. To me, it is economizing at the wrong end—you must have a good equipment, whatever else you have.

Supposing the American companies, in earning £1 of revenue, spent 27s. in obtaining it, what action would be taken by those in charge?—It would be considered an unbusinesslike proposition. A telephone system that does not pay for itself is a system that cannot last, unless, of course, supported, *pro bono publico*, by a paternal Government. In America, they find that by taking the public into their confidence, and assuring the public that the company has not been watering its stock, and that only a fair profit is made, the public are satisfied, and will pay a price sufficient to make a reasonable profit, if the service is satisfactory.

APPENDIX XXXIX.—*continued.*

By the Chairman.—The Commonwealth Chief Electrical Engineer is in charge of a service of between 50,000 to 70,000 telephone subscribers. What would be paid to an electrical engineer to take charge of a similar proposition in America?—There you touch upon a matter of which I have not the slightest idea. I am not a business man. I know the companies pay what are considered high salaries to their electrical engineers, to secure the best men, but what these salaries are I do not know. It is well understood that it is poor economy to economize upon the salaries of electrical engineers—for the success of the service as a whole depends very greatly upon the abilities of the electrical engineers.

Do you think that the Commonwealth chief electrical engineer should be a consulting engineer, instead of having charge of telephonic construction, as well as telegraphic construction?—That would be my idea, but I do not trust my judgment upon a question of that character.

For such a position would he not require to be a high-class man?—Yes, certainly.

Would you consider £750 a year sufficient for that class of man?—In Australia you have a different scale from that in America. I do not know what salaries we pay. My impression is that the salaries for good engineers are not very much different from the amount you have mentioned. Of course, the chief engineer of the American Telephone and Telegraph Company might get any amount. You cannot economize on brains.

Do you consider that a high-class man would save his salary over and over again?—Yes. It is absolutely necessary to have a high-class engineer, and you can only get good men by paying a high salary.

Witness withdrew.

APPENDIX XL.

I, Ernest Graham Godfree, of Sandringham, in the State of Victoria, sincerely declare that the written (typed) statement of information furnished for the Postal Commission by me in reference to details of my invention, "The Electro-mechanical Selector," and in connexion with evidence concerning this instrument, given Postal Commission by Dr. Alex. Graham Bell, is a true and reliable one prepared by myself, for the purpose of supplying that matter which Dr. Bell, in the short time at his command, did not elucidate from me when he kindly inspected my Selector at the Victorian Rail-

way Telegraph Engineers' Shops, at Spencer-street, on 12th August last. And I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of an Act of the Parliament of Victoria, rendering persons making a false declaration punishable for wilful and corrupt perjury.

Declared at Melbourne, in the State of Victoria, this eighth day of September, One thousand nine hundred and ten (1910), before me, Robert A. Robertson, J.P., a Justice of the Peace, in and for the Central Bailiwick of the State of Victoria.

ERNEST GRAHAM GODFREE.

I have to hand an extract from the evidence furnished to the Postal Commission by Dr. Graham Bell in regard to my Telephone Selector. To remove that which may create a false impression, I offer the following information:—

Regarding Novelty.—I have taken a keen interest in matters of this description, and have all the latest literature dealing with Selectors to hand, but I have not seen or heard of any machine that does what I claim for mine. Selectors are used in America for train despatching, and are unsuitable for private work or connexion with exchanges. They call from one end only. Intermediate stations cannot select one another. They are not secret. They are complicated in construction and in operation. They use more than one line wire. They use very large battery power to work them. The "Gill" is considered the best production up to date, but it is not used for exchange work or private lines. I would be pleased to furnish you with particulars in regard to it if you require to make a comparison.

Mr. Poynton, of the Railway Department, who has just returned during last month, from United States of America, informs me that he was particularly interested in this direction, and gathered information whilst there relating to Telephone Selectors, but that mine was much superior, being simpler and more efficient. He did not see or hear of any that would allow of inter-communication between intermediate stations.

In reference to impedence being offered to the speaking circuit by the electro-magnets—I have provided for this where there are a large number of telephones; a condenser will be inserted in bridge across the Selector coils which will have the effect of giving a clear talking circuit. There is no difficulty in doing this. I do not see any difficulty in the adaptation of the Selector for exchange work.

The principle of the machine is called the "step by step" motion, and is not novel, being in some of the earliest electrical machines, but it is a reliable movement. The adjuncts that surround this principle constitute my claims for invention.