EVIDENCE BEFORE THE MASSACHUSETTS COMMITTEE ON STREET RAILWAYS AS TO THE SAFETY OF OVERHEAD ELECTRIC WIRES, FEBRUARY-MARCH 1889

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FEBRUARY—MARCH,

1889.

BOSTON:
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TESTIMONY OF ELIHU THOMSON.

Q. (By Mr. HYDE.) Will you state to the Committee whether the current that is used in street cars is dangerous to life? What progress has been made and what success may be expected of it in the future operation of street cars? Please state as fully as you can, in such form that the Committee will understand it.

A. The growth of electric railways has undoubtedly been very rapid of late, and as you have heard stated here, there are something like fifty roads in operation at the present time. The experience of those roads has dated back several years. Some of them, no doubt, were crudely arranged at first, but the whole matter is becoming rapidly systematized and taking very much better shape. In order to convey electricity any considerable distance it is necessary that we provide conductors to convey the current. We must also use a certain pressure on the current or the electricity will fail to be carried. In arc lighting this pressure rises to as high a point sometimes as 3,000 volts, and yet I have known men to come in contact with such wires, getting the full strength, and not be killed. There are a few other cases where people have met with fatal accidents by putting their hands on wires with a current of from 2000 to 3000 volts. By common consent, however, the electrical fraternity have dropped down to a voltage as low as 500 volts. That is the voltage which is now used on electric railways. The object of dropping the voltage is to get two things; that is, to secure safety and at the same time secure freedom from the tendency of the current to leave the wire, either on the car or anywhere else. The desire is, of course, to keep that pressure which will transmit the current over the line. We could operate the roads with 1500 to 2000 volts, but that is not feasible or advisable; we would find more difficulties in the construction of our motors. We are forced to keep the current down in pressure. A great deal has been said about the volume of the current existing on these lines. I say that that has nothing to do with it whatever. The volume of the current is nothing; it is merely the pressure which is to be taken into account; and this whole question hinges on whether 500 volts is a dangerous pressure or not. That is the whole thing,—whether 500 volts is a dangerous pressure or not. Now, it is a fact, as I am told, that the Western Union Company use on some of their lines in New

York City more than 400 volts; they use dynamos for working long lines. I have heard of various instances where the leakage in bad weather has been so strong that the instruments were overcharged and the operators could not even adjust their instruments with the pressure being as great as that. They use the dynamos to replace a certain number of battery cells. The number which they would replace of the Gove type, taken as an example, would be about 240 battery cells. It does not seem to them that that voltage has any particular danger in it.

Mr. POPE. They have used it for fifteen years.

Mr. THOMSON. They have used it for fifteen years, as Mr. Pope says. They have substituted dynamos having a current of large capacity in place of their batteries, and still they find no difficulties with it. The pressure is not high enough to do any harm to the person. It is true that it is a pressure which will give a shock. Nobody denies that. Almost any pressure will give a shock, but the question here is whether it is capable of giving a fatal shock. I do not think any evidence has been produced here this morning which shows that it can produce a fatal shock, or has produced a fatal shock, which is the important point. There are fifty roads in operation. We are prepared to produce testimony in regard to persons who have come in contact with a current and have not been injured more than to get an electric shock. I have occasionally touched conductors of very much higher voltage than these. I at one time caught hold of a conductor having a voltage of 10,000 volts for a few moments. I got a very severe shock, but it did not kill me. On one occasion I caught hold of an alternating current of 1,000 volts, which you have spoken of as an exceedingly dangerous current, and that did not kill me. I do not say that I would voluntarily take hold of one of these conductors and take that shock, any more than I would go and have a tooth extracted without any reason for it. But I do say that the escapes from serious injury from much higher voltages than 1,000 volts are frequent. The voltage which is now used on electric railways has been reduced to that which has been agreed upon as the practical pressure to use, involving safety and efficiency throughout the whole system. We could not do better than that; that is certain.

A good many points have been brought up here which it is hardly worth while to touch upon, but I am impressed with their contradictory character in many cases. Sometimes we hear of the impossibility of touching the wires and of the impossibility of firemen cutting the wires, because they are dangerous. We hear the statement made that

firemen will receive shocks. All they have got to do is simply to have nippers with a wooden handle. They can cut any wire without any trouble. The wires can be cut very nicely by an ordinary pair of pliers without any danger whatever. I can say that there is not the slightest difficulty in removing all the wires in a very short time, if you choose, without any danger to people standing by.

Q. Take a trolley wire, what is the size of it right through?

A. It varies with the number of cars. It always has to be a heavy wire to carry the current. It is a very strong wire.

Q. I am speaking with reference to the difficulty of cutting it with a pair of shears with wooden handles?

A. There is no trouble at all. With a pair of cutting pliers wires can be cut very much thicker than that. With proper tools you can get a leverage that will do almost anything. Even if the wire were three-quarters of an inch thick it could be easily cut. It is not steel wire, it is copper wire.

Q. Supposing there is a fire and there is occasion to cut the wires and they are cut, what is the effect upon the operation of the road at other points?

A. The operation at other points is preserved. If the feeding lines for the current come in on two sides of a fire you can still run the cars. There is another point here. You can utilize this power in connection with electric fire engines. Supposing a steam fire engine should get out of fuel, you lose it, but with electric pumps you have a reliable power at the central station which will not fail you. That time will surely come, and when it does you will have an effect which will counterbalance the fire risks, which are being now exaggerated.

Q. In regard to the falling of other wires on the central conductor, is it the fault of the electric road wires if the other wires come down?

A. It is the fault of the wires that come down. Make your telephone wires strong and they will not come down as far as the electric road wires. Those wires ought to be supported better than they are and then they will not come down. They are flimsy; they are not properly supported. Support them as you would the electric road wire, which has to stand the jar of the trolley, and they will not come down. But the matter of other wires coming in contact with the conductors has always been brought up whenever a new system of wires has been introduced, and every system which has been introduced has been stronger than others, and the failure has been the failure of the lighter wires all through. The iron wires rust out and on the slightest provocation they drop down on the other wires; but danger from that can

be easily obviated. Suppose you run out guard wires at short distances above the central wire, then if a wire drops down it will not sink to the car current line. Ground the heavy guard wire and have a line come down on it. If it touches the electric road wire it will burn the connecting link in a moment. There is no telephone wire in use which would not be burned out in an instant. If this safeguard cannot be provided you have still others, but simply grounding the upper wire—connecting it with the ground—suffices. Now, if the telephone wire sags from any cause, in almost all cases it will not probably touch the under wire at all, and in any case in which it does touch it will produce such a flow of current that the wire will simply break the connection, leaving you as before in extra good condition to carry your current to the cars. These are all precautions which can be adopted and are well known at the present time.

Q. As to persons riding on the cars, is there any danger either to persons who are riding in the cars or to their watches by the use of the overhead system?

A. The danger to persons is absolutely nill. The conductor comes up from the top of the car and is heavily insulated. That is necessary in order to have it stand moisture. It would give out at once if we did not have the circuit on the car thoroughly insulated, covered in as fully as possible, to prevent it from coming in contact with the car track itself. In fact, a car body is constructed of material which will not convey a current of 500 volts at all. As to the danger to watches, although I have not heard any complaints of any trouble of that kind, I should say that there might be some little effect on watches not made non-magnetical; but the great watch firms now-a-days are making watches which will get over that difficulty. In fact, it is being regarded as essential that a man must be equipped with a non-magnetic watch in these days of electrical growth. I have in my pocket a time-piece of that character, which I can put on a dynamo with the strongest possible magnetic field and it will not affect its running at all.

Q. Supposing a car runs in a thunder shower, what is the effect of that?

A. Well, the general experience has been that as the number of electric wires increase in a city there is less trouble from thunder storms. That is, there are so many points of escape for lightning discharges that very few places in cities are struck and injured during a thunder storm. In the country, in a suburban district, a wire of course might be struck, but look at the chances of its going to the ground! It is only insulated by a little porcelain knob from the side wires,

which are often connected by a most complete circuit with the ground, and we also provide lightning arresters, putting them along the line as often as they may be needed, for carrying off any charge which could jump more than one-sixteenth of an inch. Lightning will jump a mile in many discharges. I would put a line of lightening arresters along the road which would carry off any current that can jump one-sixteenth of an inch, to the ground. Is not that sufficient protection? The fact is, if the lightning ever strikes a line it will find a number of points of escape and will not affect the car or go through the car; it will jump at once at the lightening arrester.

Q. As to the capacity of a car equipped with electricity in this way — to what extent is it capable of doing the business?

A. There is wonderful flexibility in the system. The motors, when properly constructed, can be run up to a very much higher point than their normal, ordinary capacity; so much so, that I have known instances of an electric car pulling two other cars loaded, and on an up-grade at that. So that under stress we have everything that we want. The power goes to that portion of the line which needs the power, and to the lighter loaded portions in proportion to the reduced load. That depends altogether on the amount of current which flows through the motor under any given conditions, and that amount of current is under control, varying with the speed of running. A little slower speed makes the current larger, makes the car capable of pulling a little heavier load.

Q. (By Mr. Ries.) I would like to ask Prof. Thomson whether the use of the small size wires to which he has referred would not require a current higher than 500 volts?

A. That is a technical question which calls for expert information. I am quite willing to give it. I would in all cases run feeder lines and conductors altogether independent of the main line. You may run any number of cars, a thousand cars, if you please, under that system. You can put a feeder line under ground; the potential is not so high but that you can easily handle the underground feeders. There is no question that you can put a feeder underground. Of course we can run a million cars with 500 volts under that system.

Q. From one generating station?

A. From one generating station.

Q. Could you do that in the same way that you handle it on the West End?

A. No, sir, I don't say so. I say that as your power runs up you would have to add an additional feeder line and you would work by

a central power station one or more. The car companies will settle that. They will say: "If we want a power station here, we will put it here; if we want a power station there, we will put it there."

Q. How many amperes will you carry on the wires to which you refer, those wires that you can cut with shears?

A. Up to the maximum.

Q. What is that maximum?

A. The maximum is that which never heats a wire, produces not the slightest effect upon it.

Q. How many amperes?

A. The experience of some roads is that it takes eight or nine horse-power to a car. That can be figured out very easily. You can do that.

Q. What I want is a rough statement as to the number of cars you can supply from the ordinary overhead wire which you can cut conveniently with the shears?

A. By putting your feeder wires anywhere you please you can supply any number of cars.

Q. Would it not be necessary to run a very large spiral and more conductors and feed wire?

A. That is a question for the companies. If they are willing to put in copper wire, why need you complain?

Q The question is, if you were to operate a system of street railway cars, such as are run in the streets of this city, with overhead conductors, pure and simple, without any underground feeders, would you not have to use copper wires which would be inconvenient to cut and which would require poles to support them?

A. I don't think you would. It would depend upon the condition of the power station altogether.

Q. If you had one power station?

A. I am not dealing with things which are not in accordance with good practice. I am dealing with good practice in all cases.