large, silence ensues;—that when properly adjusted, a rapid bombardment of moveable atoms between the electrodes occur, very quickly from the positive and more slowly from the negative poles. And he instanced the following curious experiment, under microscopic observation, that when a drop of oil was placed between two platina pointed electrodes and a current passed through them, a great disturbance took place between the particles of oil, which rotated between the points with wonderful rapidity, one point becoming hotter than the other, as in the electric are light, although reversing the polarity did not *invariably* reverse their heat.

Professor Sylvanus Thompson stated that the snap sounds heard in telephones, which are generally attributed to make and break contacts, are really due to sparks between the electrodes, and that when such sparks are suppressed the noises cease and that they can be almost entirely eliminated (even when very strong currents are used) by introducing double differentially wound electro magnet into the circuit.

In this connection Mr Stroch observed that when new carbons are used, at their first contact, they click and then vibrate, with such rapidity as sometimes to produce musical sounds, which cease as the spring or weight pressure is increased, and until vibrations are again started by sound waves. And that if a watch were placed upon a microphone, all kinds and qualities of sound could be obtained by manipulating the points, thus clearly proving that it is not the tick of the *watch* which is heard, but the microphones *own sounds*, started by the tick of the watch; and that from such fact it would appear that the mechanical movements due to sound waves have the effect of governing and controlling the frequency, amplitude, and form of the vibrations which the microphone sets up through every disturbance of its equilibrium.

Professor Thompson further stated that by using a differentially wound induction coil in the transmitter, not only is articulation greatly improved, but the vibratory induction disturbances, from approximate running machinery, are inocuous even to a sensitive Blake transmitter, and that two small induction coils, having their primary wires united in parallel and their secondaries in series, gave a much more satisfactory result than is obtainable from the ordinary coil in present use.

That granulated hardened coke, as used in the Hunning's transmitter, presents more numerous points of contact than two solid electrodes, and hence the greater vibratory effect produced in a distant receiver; but that comparative tests between metallic alloys, demonstrate, that a platina point, resting upon an electrode of copper, treated either with a mixture of silenium and sulphur, or with tellurium, reproduces speech with a clearness of articulation far superior to anything obtainable from hard carbon, although such alloy requires a greater initial pressure, at the electrodes, than is required by carbon.

For many practical reasons, I consider this latter statement of Professor Thompson's an important one.

Professor Thompson then exhibited a transmitter, designed with the object of dispensing with the patented diaphragm. At the small end of a speaking tube, a ball or valve of metal rested upon three metallic points and the sound waves suspended, or in part relieved, the weight of the ball; but Professor Hughes observed, that if the tube was plugged below the valve and the air allowed to escape through side holes, the instrument remained equally effective, thus proving that the tube itself became a diaphragm of different form, and that under any circumstances, for well known mechanical reasons, the practical limitation of three points of support would render the instrument less powerful than many others in use.

The experimental transmitter just described will serve in great measure to explain the broad claim allowed at law in favor of the *diaphragm*, as patented by Professor Bell.

It appears, however, that a simple grid of small carbon bars, suspended upon a platina wire, within a more vibrating leaden frame, and acted upon direct by sound waves, proves to be an effective transmitter, and by such device a diaphragm may be totally dispensed with.

Professor Hughes stated that if a series of small bars or pencils of carbon were attached to the inside rim of a bowl, or box, filled with water in order to eliminate the hollow tones of such receptacle, such a transmitter would operate with increased power, because every portion of the water would then be in a state of tremor from the sound waves.

This remarkable power of water for conveying sounds has already been utilized for discovering leaks in water pipes; even the leakage of a few drops may be localized by the application of a delicately constructed telephonic receiver; and I have little doubt but that under favorable circumstances distinct signals can be telephonically conveyed through several miles of water.

Magneto electric transmitters have, since the introduction of the microphone, been superseded by local circuit battery power transmitters; but I am of opinion from practical experiments made with the "Gisborne & Keeley" patented telephone, purchased by the Bell Telephone Co. of Canada, that it is desirable, if possible, to dispense with the always uncertain and varying action of introduced galvanic battery power.

Professor Thompson suggested a transmitter based upon the principal of a dynamo-electric machine; but the advantages of such mode of increasing the power of the currents would be more than counterbalanced by the increased inertia consequent upon the to and fro movement of the armature.

In concluding his observations at the meeting to which I have reference, Professor Thompson stated that in his opinion the progress of long distance transmission of speech would depend upon increasing the power of the transmitter, and reducing the sensitiveness of receivers to induced sounds from extraneous disturbances.

To such general conclusion Mr. W. H. Preece (electrician to the London Post Office and telegraphs,) took exception, and stated that clearness of articulation and long distance telephony depended entirely upon the line wires being freed from electro-static and electro-magnetic induction, and that when the environment was favorable, the most ordinary form of instruments would convey speech as well over long as over short circuits. That the law, which determines the transmission of currents through a wire, to produce speech, is precisely the same, in every respect, as the law which determines the flow of currents through submarine cables, and that it is absolutely impossible, to obtain any greater number of signals, along a given conductor, by any alteration or improvement in the instruments.

That the ratio values of conductors were as follows: iron 1,000, copper in cables 1,200, copper exposed 1,500. That the difference between iron and copper was due to the self induction of the iron; and between copper in cables and copper exposed, the difference was entirely due to the insulation of the former; the leakage from suspended wire enabling it to discharge its static charge, and still more quickly from a suspended copper than from an iron wire.

That experiments showed, that when the speed of the currents was .004 to .003 of a second, the transmission of speech was bad; when .003 to .002, it was fair; when .002 to .001, it was good; and if under .001, perfect.

And that the average number of sonorous vibrations in the human voice, was about 1,500 per second. Experiments made upon the Irish cables and lines proved the relative values of the different circuits, and that even with a powerful "Berliner" transmitter, the rate of speaking was neither increased nor varied from the result obtained when ordinary transmitters of much less power were used.

That Professor Fleming Jenkins had verified the law of static induction and consequent retardation of signals, through the French Atlantic cable of 2500 miles in length, when he found it possible to obtain 2½ reversals of current, per second; and that both theory and practice demonstrated that speech was limited in such class of cable to a distance of not exceeding 96 to 100 miles of its length.

That telephonic disturbances are principally due to secondary currents induced by primary currents in neighboring lines, and that short circuits are more disturbed by such influences than are long circuits, such disturbances being due, not merely to the strength or potential of neighboring currents, but to the rate at which said currents rise and fall.

That although the effects of induction might in some measure be neutralized by strengthening the transmitter and weakening the receiver, it would be almost impossible to convey intelligible speech, when very strong currents (such for instance as were used in a Wheatstone transmitting telegraph) were traversing neighboring lines, the induction effects from said currents being 100,000 times stronger than telephonic currents.

Professor Hughes was of opinion that greater attention should be given to the transmitter induction coils, and that the battery cells and primary wire of the coils should be in proportion to the internal resistance of the transmitter; and he agreed with Professor Thompson, that more powerful transmitters and less sensitive receivers indicated the path of progress in telephony.

Professor Bidwell held, that the constituent elements of a transmitter should be an arrangement in multiple-arc of heavy carbon pencils, with light points of contact, that the resistance of such a microphone should be proportionately as small as the rest of the circuit, and that the current should be as strong as the number of contacts and amount of pressure would warrant.

With due regard to the foregoing views and experiments of eminent electricians, I venture to express my opinion.

That clearness of articulation and natural tones are best obtainable from magneto-electric transmitters, which are free from the disturbing and varying action of local galvanic cells.

That loudness, and progress in long-distance telephony, will depend in great measure upon increased power in the transmitter and decreased sensitiveness in the receiver.

That whereas it is impracticable to control the environments of telephone wires, attention must be given to the elimination of induced disturbing currents, by utilizing twisted all-metallic circuits, or some equivalent device.

That economy in line construction can be effected by utilizing one such twisted all-metallic circuit, of low resistance, for several exchange connections.

In conclusion of this paper, which has been compiled with the sole object of inviting discussion upon one of the most important inventions of the nineteenth century, I may add that after my return from England I hope to be able to give some further items of interest (and notably that make and break currents are not detrimental to the transmission of speech), for the consideration of the members and associates of the Canadian Society of Civil Engineers.

F. N. GISBORNE.

OTTAWA, July 1st, 1887.