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Working Paper 3

Édouard-Léon Scott de Martinville's "Fixation Graphique de la Voix" (1857)

A Critical Edition

with English Translation and Facsimile

Patrick Feaster

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Édouard-Léon Scott de Martinville's "Fixation Graphique de la Voix" (1857)

Édouard-Léon Scott de Martinville delivered a talk on the phonautograph before the Société d'Encoragement on 28 October 1857, and in November he had its text printed by J. Claye for private circulation under the name *Fixation Graphique de la Voix*.[1] Scott later reprinted his talk as Document No. 3 in his self-published book, *Le problème de la parole s'écrivant elle-même* (Paris, 1878), this time working from his original manuscript rather than from the 1857 imprint. Points at which the 1878 text diverges from the 1857 imprint are identified here in the footnotes. Unfortunately, any relevant archives of the Société d'Encouragement itself appear to have been lost years ago to water damage.[2]

Scott's other writings—his patents, his sealed packets and communications to the Académie des Sciences—are aimed at specialist audiences. By contrast, this talk targets the general listener, the person who is "ignorant of the science of sound." It is the least technical of Scott's explanations of the phonautograph, and also the most consciously poetic.

This particular piece of writing was also instrumental in introducing Scott's ideas to the English-speaking world. The abbé François Moigno reprinted part of Scott's account as "Phonautographe et fixation graphique de la voix, par M. Édouard-Léon Scott" in *Cosmos* 14 (1859), pp. 314-320, and went on to introduce Scott's phonautograph at the September 1859 meeting of the British Association for the Advancement of Science.[3] Before that event, an English translation based on Moigno's redaction of Scott's talk appeared in the London-based *Photographic News* of 15 April 1859, pp. 62-4, and is included here in facsimile as an appendix. We believe it to be the only piece of Scott's writing that appeared in English during his lifetime.

Patrick Feaster

[1] We are indebted to Ulrich Stock of *Die Zeit* for the facsimile of the 1857 imprint used as the basis for this edition.
[2] Andrew J. Butrica, "Historical Collections in Jeopardy: The Société d'Encouragement pour l'Industrie Nationale," *Isis* 88:2 (June 1997), 296-301.
[3] *Report of the Twenty-Ninth Meeting of the British Association for the Advancement of Science; Held at Aberdeen in September 1859* (London: John Murray, Albemarle Street, 1860), 62.

ORIGINAL

{1878:[38]}

Pièce n° 3.
Communication à la Société d'Encouragement en date du 16 novembre 1857.

Monsieur le Secrétaire,

Je viens vous prier de vouloir bien recevoir, au nom de la Société, le paquet suivant, et d'y apposer son cachet et la date. Il est destiné, si vous le jugez convenable, à être mis sous les yeux des personnes qui vous demanderaient des renseignements sur la question. J'ai fait imprimer, pour ne pas la copier à la main, la pièce ci-jointe à cent exemplaires seulement pour les membres du Conseil et vingt membres de l'Académie des sciences. Elle n'a pas d'autre caractère que celui d'une simple communication orale à la Société d'Encouragement.

J'ai l'honneur d'être, Monsieur, votre très-humble et très-dévoué serviteur,

LÉON SCOTT.
Ce 16 novembre 1857.

* * *

Voici la transcription de cette pièce, imprimée chez Claye en un placard petit in-folio, tiré d'un seul côté. Elle est devenue tellement rare qu'il m'a été impossible de m'en procurer un seul exemplaire. Je me sers pour la copier du manuscrit livré au compositeur avant les corrections. Je ne puis donc pas garantir la conformité absolue de ma copie avec la placard de 1857, mais les différences doivent être insignifiantes. M. Moigno l'a reproduite en partie dans le *Cosmos* en 1859.

* * *

{1857:[1][4]} M. Édouard-Léon Scott présente à la Société d'Encouragement une nouvelle série d'épreuves négatives indiquant le mouvement des membranes minces et de certains solides sous l'influence des instruments de musique et de la voix. A la fin de la séance il **{1878:39}** demande[5] la parole pour donner quelques explications sur ses procédés,[6] et s'est exprimé en ces termes:

TRANSLATION

Document No. 3
Communication to the Society of Encouragement dated 16 November 1857.

Mr. Secretary,

I am going to ask you to be so kind as to receive, in the name of the Society, the following packet, and to affix thereon its seal and the date. It is intended, if you deem it suitable, to be placed beneath the eyes of persons who should request from you information on the question. I had printed, in order not to copy it by hand, the attached document in a hundred copies solely for members of the Council and twenty members of the Academy of Sciences. It has no other character than that of a simple oral communication to the Society of Encouragement.

I have the honor to be, Sir, your most humble and devoted servant,

LÉON SCOTT.
This 16 November 1857.

* * *

Here is the transcription of this document, printed by Claye on a small folio placard, imprinted on only one side. It has become so rare that it has been impossible for me to procure myself a single copy thereof. For copying it I used the manuscript delivered to the compositor before corrections. I cannot therefore guarantee the absolute conformity of my copy with the placard of 1857, but the differences must be insignificant. M. Moigno reproduced it in part in *Cosmos* in 1859.

* * *

M. Édouard-Léon Scott presents to the Society of Encouragement a new series of negative prints showing the motion of thin membranes and certain solids under the influence of musical instruments and the voice. At the end of the session he asks to speak in order to give some explanations of his processes and expressed himself in these terms:

[4] The page is headed "FIXATION GRAPHIQUE DE LA VOIX."
[5] 1878 text has "a **{1878:39}** demandé" = "requested."
[6] 1878 text lacks comma.

ORIGINAL	TRANSLATION
«Messieurs, je viens vous annoncer une bonne nouvelle: Le son, aussi bien que la lumière, fournit à distance une image durable;[7] la voix humaine s'écrit elle-même (dans la langue propre à l'acoustique, bien entendu) sur une couche sensible; à la suite de longs efforts je suis parvenu à recueillir[8] le tracé de presque tous les mouvements de l'air qui constituent soit des sons, soit des bruits. Enfin, les mêmes moyens me permettent d'obtenir, dans certaines conditions, une représentation fidèle des[9] mouvements rapides, de mouvements inappréciables à nos sens par leur petitesse, de mouvements moléculaires.	"Gentlemen, I am going to announce to you a piece of good news: sound, as well as light, furnishes a durable image at a distance; the human voice is written by itself (in the language peculiar to acoustics, of course) on a sensitive film; following long efforts I have managed to collect the trace of almost all the motions of the air which constitute either sounds or noises. Indeed, the same means permit me to obtain, in certain conditions, a faithful representation of the rapid motions, of motions inappreciable to our senses by their smallness, of molecular motions.
«Il s'agit, comme vous voyez, dans[10] cet art nouveau, de forcer la nature à constituer elle-même une langue générale écrite de tous les sons.	"It is a matter, as you see, in this new art, of forcing nature herself to constitute a written general language of all sounds.
«Lorsque la pensée me vint, il y a plus de quatre ans, de fixer sur une couche sensible la trace du mouvement de l'air pendant le chant ou la parole, les personnes auxquelles je confiai mon projet ne manquèrent pas, pour la plupart, de le traiter de rêve insensé. Le mot, Messieurs,[11] ne me parut pas tirer à conséquence: il est la bienvenue ordinaire de plus belles conquêtes de l'intelligence humaine,[12] et mes faibles efforts avaient cela de commun avec beaucoup de grandes choses qui ont commencé par être des utopies à leur berceau. Je dois convenir, toutefois, que ce jugement sommaire n'était pas sans quelque apparence de raison. Qu'est-ce que la voix, en effet? Un mouvement périodique[13] de l'air qui nous entoure, provoqué par le jeu de nos organes;[14] mais un mouvement très-complexe et infiniment délicat. Cette délicatesse est telle, Messieurs,[15] que si vous parlez dans une chambre sombre, éclairée par un seul rayon de soleil, les plus fines poussières en suspension dans le fluide,[16] et visibles seulement dans l'espace lumineux, ne seront pas agitées d'une manière sensible.[17]	"When the thought came to me, more than four years ago, of fixing on a sensitive film the trace of the motion of the air during song or speech, the persons to whom I confided my project did not fail, for the most part, to treat it as a foolish dream. The word, gentlemen, did not seem to me to be of consequence: it is the ordinary welcome of the most sublime conquests of human intelligence, and my feeble efforts have that in common with many great things that started in their cradle by being utopias. I must admit, however, that this summary judgment was not without some semblance of reason. What is the voice, indeed? A periodic motion of the air which surrounds us, caused by the working of our organs; but a motion very complex and infinitely delicate. This delicacy is such, gentlemen, that if you speak in a dark room, lit by a single ray of sun, the finest specks of dust in suspension in the fluid, and visible only in the bright space, will not be agitated in a perceptible manner.

[7] 1878 text has comma for semicolon.
[8] 1878 text has "obtenir" = "obtain."
[9] 1878 text has "de" = "of rapid motions"
[10] 1878 text has "par" = "by this new art"
[11] 1878 text lacks "Messieurs"
[12] 1878 text lacks comma.
[13] 1878 text lacks "periodique."
[14] 1878 text has comma for semicolon.
[15] 1878 text lacks "Messieurs."
[16] 1878 text lacks comma.
[17] 1878 text inserts endnote P *bis* (p. 71; note that, despite Scott's placement of quotation marks, the first *three* paragraphs are quoted from François-Achille Longet's *Traité de Physiologie*):

ORIGINAL	TRANSLATION
D'un autre côté, ce mouvement si subtil est extrêmement rapide. Tandis **{1878:40}** qu'en ce moment je vous parle dans le ton ordinaire de ma voix,[18] plus de six cents de ces invisibles mouvements de l'air se succèdent entre moi et vous[19] dans l'intervalle si court qui sépare deux battements du pouls, c'est-à-dire une seconde.	On the other hand, this motion so subtle is extremely rapid. While I am speaking to you at this moment in the ordinary pitch of my voice, more than six hundred of these invisible motions of the air are succeeding one another between me and you in the interval so short which separates two beats of the pulse, that is to say one second.

"J'ai beaucoup exagéré ici le peu de valeur dynamique de la phonation: je suis bientôt revenu à des idées plus saines. Je n'avais pas encore consulté les expériences de M. Cagniard- Latour sur la question dans le journal l'*Institut*, n° 228, janvier 1838: «Il résulte de ces expériences qu'une personne observée par lui exerçait des pressions de 7 centimètres de mercure quand elle prononçait son propre nom à haute voix, comme lorsqu'on appelle quelqu'un; de 5 à 6 centimètres de mercure pendant qu'elle riait modérément; de 18 à 20 centimètres de mercure lorsqu'elle se mouchaît avec force; de 23 centimètres quand elle toussait fortement et de 24 lorsqu'elle éternuait.»

"Des expériences faites avec un manomètre à eau ont donné au même physicien une pression représentée par une colonne d'eau de 3 centimètres pendant l'expiration, et, en sens contraire, de 2 pendant l'inspiration. Pendant le chant dans un ton médium, on en a trouvé 16. Lorsque le chant, sans être plus intense, est devenu plus aigu, le manomètre est monté à 20 pour descendre à 6 quand le sujet sifflait avec la bouche un *ut* de 1024 vibrations simples par seconde. La personne ayant compté depuis un jusqu'à vingt pendant une seule expiration de 5 secondes, la pression a été comprise entre 12 et 13 centimètres d'eau.

"Sur un autre sujet, Cagniard-Latour a observé qu'en moyenne la phonation exigeait une pression d'air représentée par une colonne d'eau de 16 centimètres.

"Ces curieuses expériences sont à reprendre avec soin, en étudiant les uns après les autres les sons propres aux différentes articulations. On pourra juger ainsi de la force d'inscription dont on peut disposer dans l'exécution de l'appareil." =

"I greatly exaggerated here the little dynamic value of phonation: I soon returned to sounder ideas. I had not yet consulted the experiments of M. Cagniard-Latour on the question in the journal of the *Institute*, No. 228, January 1838: 'It results from these experiments that a person observed by him exerted pressures of 7 centimeters of mercury when she pronounced her proper name aloud, as when one calls someone; of 5 to 6 centimeters of mercury while she laughed moderately; of 18 to 23 centimeters of mercury when she blew her nose with force; and of 24 when she sneezed.'

"Some experiments made with a water manometer gave to the same physicist a pressure represented by a column of water of 3 centimeters during exhalation and, in the opposite direction, of 2 during inhalation. During song at a medium pitch, one found 16 thereof. When the song, without being more intense, became higher, the manometer rose to 20 to descend to 6 when the subject whistled with the mouth a *do* of 1024 simple vibrations per second. The person having counted from one to twenty in a single exhalation of five seconds, the pressure was contained between 12 and 13 centimeters of pressure.

"On another subject, Cagniard-Latour observed that on average phonation required a pressure of air represented by a column of water of 16 centimeters.

"These curious experiments are to be resumed carefully by studying one after the other the sounds characteristic of the different articulations. One will thus be able to judge the force of inscription one can have at one's disposal in the operation of the apparatus."

[18] 1878 text substitutes "qu'on parle dans le ton ordinaire de la voix" = "while one is speaking in the ordinary pitch of voice."

[19] 1878 text lacks "entre moi et vous."

ORIGINAL	TRANSLATION
«Ce mouvement particulier qui produit la sensation du son est-il apte à engendrer, comme un faisceau lumineux, en chacun des points de l'espace qui nous entoure, un spectre doué d'une certaine persistence et dont un écran sensible puisse être chimiquement impressionné? Non, Messieurs,[20] le spectre sonore (passez-moi cette expression inexacte) n'est pas permanent comme le spectre lumineux. Ce trouble momentané, ou mieux,[21] cette oscillation, suivant certaines lois, des molécules du milieu aérien, une fois l'ébranlement communiqué au fluide par le jeu de nos organes, s'y propage de proche en proche avec une vitesse de 333 mètres par seconde;[22] la vibration moléculaire passe donc à une station quelconque en un instant d'une brièvité inappréciable à nos sens, et quand elle a franchi ce point, tout est déjà rentré au repos dans l'espace précédemment parcouru. Une action chimique nous paraît irréalisable par suite de cette mutation incessante du phénomène en chaque point.	"Is this distinctive motion which produces the sensation of sound apt to create, like a bright beam in all points of the space which surrounds us, a given spectrum of a certain persistence and by which a sensitive screen could be chemically impressed? No, gentlemen, the sound spectrum (forgive me this inexact expression) is not permanent like the light spectrum. This momentary disturbance—or, better, this oscillation following certain laws—of the molecules of the aerial medium, once the agitation is communicated to the fluid by the working of our organs, propagates itself therein from place to place at a speed of 333 meters per second; the molecular vibration therefore passes to any station in an instant of brevity inappreciable to our senses, and when it has got past this point, everything has already returned to rest in the space previously traversed. A chemical action seems unfeasible to us in consequence of this incessant change of the phenomenon at every point.
«Je demande pardon aux hommes éminents que j'aperçois dans cette enceinte, de ces détails très-connus;[23] mais je m'addresse même aux personnes étrangères à la science du son,[24] et j'arrive à des choses dignes peut-être de quelque intérêt.	"I beg the pardon of the eminent men whom I see in this hall for these well known details; but I address myself as well to persons ignorant of the science of sound, and I am getting to things worthy perhaps of some interest.
«Comment parvenir, je vous le demande,[25] à recueillir une trace nette, précise, complète, d'un pareil mouvement, incapable, disons-nous,[26] de faire frémir un cil même de notre paupière? Ah! si je pouvais poser sur cet air qui m'environne et qui recèle tous les éléments d'un son, une plume, un style, cette plume, ce style, formerait une trace sur une couche fluide appropriée..... Mais où trouver un point d'appui?... Fixer une plume à ce fluide fugitif, impalpable, invisible, c'est une chimère, c'est impossible!	"How to succeed, I ask you, in collecting a clear, precise, complete trace of such a motion, incapable, let us say, of making tremble even a lash of our eyelid? Ah! if I could place in this air which surrounds me and which harbors all the elements of a sound, a pen, a stylus, this pen, this stylus would form a trace upon a suitable fluid film.... But where to find a point of support? To fix a pen in this fugitive, impalpable, invisible fluid—this is a dream, this is impossible!

[20] 1878 text does not capitalize "messieurs."
[21] 1878 text lacks comma.
[22] 1878 text begins a new sentence here.
[23] 1878 text has comma for semicolon.
[24] 1878 text lacks comma.
[25] 1878 text lacks "je vous le demande."
[26] 1878 text lacks "disons-nous."

ORIGINAL

«Attendez. Ce problème insoluble, il est résolu quelque part.[27] Il **{1878:41}** existe, Messieurs,[28] un inventeur, un artiste sublime pour lequel rien n'est absurde ni[29] impossible: c'est Dieu. Consultons-le. Considérons attentivement cette merveille entre toutes les merveilles, l'oreille humaine. Je dis que notre problème est résolu dans le phénomène de l'audition,[30] et que les artifices employés dans la structure de l'oreille doivent nous conduire au but. Je ne prétends pas faire en ce moment, Messieurs,[31] une incursion dans le domaine des physiologistes; mais je vais chercher mon bien où il se trouve. Je n'ai d'ailleurs besoin d'aucune théorie nouvelle sur l'appareil de l'ouïe et son fonctionnement.

«Ce point trouvé, les choses vont devenir d'une simplicité rare. Que voyons-nous tout d'abord dans l'oreille? Un conduit. Mais qu'est-ce qu'un conduit? Une expérience mémorable, due à l'illustre doyen de l'Académie des sciences, va nous en fournir une explication complète, applicable à notre objet.[32] Au commencement de ce siècle, pendant une nuit,[33] M. Biot, placé à l'une des extrémités d'un conduit d'aqueduc en fonte[34] d'une longueur de 951 mètres, établissait une conversation à voix très-basse, chuchotée même, avec un second interlocuteur placé à l'autre extrémité de ce tube immense. Donc, dans un conduit d'une longueur quelconque, convenablement isolé de tout mouvement extérieur, de toute agitation des couches de l'air, le plus faible murmure de la voix est transmis intégralement à toute distance. Le conduit amène sans altération, sans déperdition, l'onde sonore, si complexe qu'elle soit, d'une des extrémités à l'autre, en la préservant de toutes les causes accidentelles qui pourraient la troubler; et si le conduit est par lui-même incapable de vibrer, si aucune transmission du mouvement vibratoire ne s'accomplit dans la route, le fluide poursuivra indéfiniment son mouvement primitif avec la pureté, la netteté, l'intensité originelles. Tel est, Messieurs,[35] en acoustique, le rôle des conduits en présence d'un fluide en mouvement. Remarquez-le bien: j'en prends[36] acte pour écrire ultérieurement le son à toute distance. En attendant, je m'empare du conduit[37] et je le façonne en une sorte d'entonnoir pour concentrer les sons vers sa petite extrémité.

TRANSLATION

"Wait. This insoluble problem, it is solved somewhere. There exists, gentlemen, an inventor, a sublime artist for whom nothing is absurd or impossible: this is God. Let us consult him. Let us attentively consider that marvel among all marvels, the human ear. I say that our problem is solved in the phenomenon of audition and that the contrivances employed in the structure of the ear must lead us to the goal. I do not intend to make at present, gentlemen, an incursion into the domain of the physiologists; but I shall seek my fortune where it finds itself. Besides, I have no need of any new theory about the apparatus of the ear and its functioning.

"This point found, things are going to become of a rare simplicity. What do we see first of all in the ear? A conduit. But what is a conduit? A memorable experiment, due to the famous dean of the Academy of Sciences, will provide us a complete explanation thereof, applicable to our object. At the beginning of this century, during one night, M. Biot, seated at one of the ends of a cast-iron aqueduct conduit 951 meters in length, held a conversation in a very low voice—whispered, even—with a second interlocutor seated at the other end of this immense tube. Hence, in a conduit of any length, suitably isolated from all external motion, from all agitation of the strata of the air, the weakest murmur of the voice is transmitted in full to any distance. The conduit brings forth without alteration, without loss, the sound wave, as complex as it may be, from one of the ends to the other by preserving it from all the accidental causes that might be able to disturb it; and if the conduit is by itself incapable of vibrating, if no transmission of vibratory movement is accomplished along the way, the fluid will indefinitely pursue its original motion with the original purity, clearness, intensity. Such is, gentlemen, in acoustics, the role of conduits in the presence of a fluid in motion. Mind it well: I take note thereof later on to write sound at any distance. Meanwhile, I seize hold of the conduit and fashion it into a sort of funnel for concentrating sound towards its small end.

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[27] 1878 text has: "Ce problème insoluble est résolu quelque part" = "This insoluble problem is solved somewhere."
[28] 1878 text lacks "Messieurs."
[29] 1878 text lacks "absurde ni."
[30] 1878 text lacks comma.
[31] 1878 text lacks "Messieurs."
[32] 1878 text lacks this sentence.
[33] 1878 text has "une nuit calme" = "a calm night."
[34] 1878 text has "d'une série du tuyaux en fonte," = "of a series of cast iron pipes."
[35] 1878 text lacks "Messieurs."
[36] 1878 text has only "en mouvement: j'en prends."
[37] 1878 text has "Le conduit une fois trouvé, je m'en empare" = "Once the conduit is found, I seize hold thereof."

ORIGINAL	TRANSLATION
{1878:42} «Poursuivons l'examen de l'oreille. A la suite du conduit auditif externe, je rencontre une membrane mince, tendue et inclinée, Messieurs, dans cette architecture physique qui nous occupe?[38] Qu'est-ce qu'une mem- **{1857:2}**brane mince et demi-tendue? C'est, suivant la juste définition de Müller, quelque chose de mixte, moitié solide, moitié fluide; elle participe de l'un par la cohérence, de l'autre par l'extrême facilité de déplacement de toutes ses molécules. Elle est l'intermédiaire employé par la nature pour une[39] transmission aussi parfaite que possible du mouvement d'un fluide à un solide. Dans la construction de notre oreille, le divin artiste[40] a employé trois membranes. Tout à l'heure,[41] nous l'avons vu, le son de la voix n'ébranlait pas sensiblement les poussières suspendues dans l'espace; voici qu'à une distance de plus de dix[42] mètres, pendant la nuit, dans une salle bien silencieuse, la voix fait sauter énergiquement le sable déposé à la surface d'une membrane tendue sur un verre.[43]	"Let us continue the examination of the ear. Behind the external auditory conduit, I find a thin membrane, stretched and tilted. What is a thin and semi-stretched membrane, gentlemen, in this physical architecture which occupies us? This is, according to the Müller's apt definition, something mixed, half solid, half fluid; it partakes of the one by cohesion, of the other by the extreme facility of displacement of all its molecules. It is the intermediary employed by nature for a transmission as perfect as possible of a fluid to a solid. In the construction of our ear, the divine artist has employed three membranes. A short while ago we saw the sound of the voice did not perceptibly agitate the specks of dust suspended in space; behold, at a distance of more than ten meters, during the night, in a really quiet hall, the voice causes to leap energetically the sand deposited on the surface of a membrane stretched over a glass.
«Nous tenons maintenant, Messieurs,[44] dans tout son éclat, le fil lumineux qui doit nous conduire: ce point d'appui de notre plume sur le fluide en mouvement que je vous demandais tout à l'heure, il est trouvé, le voici. C'est[45] la membrane mince que nous plaçons à l'extrémité de notre conduit auditif artificiel.	"We now hold, gentlemen, in all its brilliance, the bright thread which must lead us: this point of support for our pen upon the fluid in motion which I asked of you a short while ago, it is found, behold it. This is the thin membrane which we place at the end of our artificial auditory conduit.

[38] 1878 text lacks "Messieurs, dans cette architecture physique qui nous occupe."
[39] 1878 text has "la."
[40] 1878 text has "l'artiste divin."
[41] 1878 text lacks comma.
[42] 1878 text has "10."
[43] 1878 text inserts endnote Q (p. 71): "J'ai reconnu plus tard que j'avais eu tort d'exagérer la minceur de la membrane de mon tympan. J'y ai remédié dans mon appareil de 1861. De même la membrane ou tympan doit être fortement tendue. Autrement elle s'impressionne trop exlusivement des ondes de condensation au détriment des ondes d'inflexion ou des vibrations tournantes." = "I later recognized that I had been wrong to exaggerate the thinness of the membrane of my tympanum. I remedied this in my apparatus of 1861. Likewise the membrane or tympanum must be tightly stretched. Otherwise it is impressed too exclusively by the waves of condensation to the detriment of the waves of inflection or of the rotating waves."
[44] 1878 text lacks "Messieurs."
[45] 1878 text has "voici: c'est."

ORIGINAL	TRANSLATION
«Je vous ai dit, il y a un instant,[46] qu'il était nécessaire, pour la solution intégrale du problème, que le style appliqué sur le fluide en vibration ou,[47] ce qui revient au même, sur la membrane, marquât sa trace sur un fluide.[48] En effet, tout mode d'inscription du mouvement[49] qui réclamerait une force de gravure appréciable serait impossible à notre burin quasi aérien.[50] La couche sensible devrait donc être fluide, afin de ne pas offrir de résistance à nos délicates empreintes. Eh bien, de même que nous avons pris un semi-solide pour agent graphique,[51] nous prendrons un semi-fluide pour matrice: ce sera le noir de fumée obtenu par volatilisation. Une mince couche déposée à l'état semi-fluide sur un corps quelconque (métal, bois, papier, tissu)[52] animé d'un mouvement de progression uniforme, afin que les traces formées ne rentrent pas les **{1878:43}** unes dans les autres, telle sera notre plaque daguerrienne, ou plutôt notre négatif, propre à fournir par les moyens connus des milliers d'épreuves.	"I said to you, a moment ago, that it was necessary, for the complete solution of the problem, that the stylus applied upon the fluid in vibration—or what amounts to the same thing, upon the membrane—should mark its trace upon a fluid. Indeed, any method of inscription of the motion that would require an appreciable force of engraving would be impossible for our quasi aerial graver. The sensitive film would need therefore to be fluid, in order not to offer resistance to our delicate impressions. Well, just as we took a semi-solid for a graphic agent, we will take a semi-fluid for a matrix: this will be lampblack obtained by volatilization. A thin film deposited in a semi-fluid state on any body (metal, wood, paper, fabric) animated by a motion of uniform progression, in order that the formed traces should not run one into the other—such will be our Daguerreian plate, or rather our negative, suited to furnishing by known methods thousands of prints.

[46] 1878 text has only "J'ai dit qu'il était nécessaire" = "I said that it was necessary."
[47] 1878 text has "vibration, ou ce."
[48] 1878 text has "marquât sa trace sur un second fluide" = "should mark its trace upon a second fluid."
[49] 1878 text lacks "du mouvement."
[50] 1878 text inserts endnote R (p. 71): "Le résultat obtenu en 1878 par M. Edison semble, au premier abord, donner un démenti à mes idées, un peu exagérées d'ailleurs et trop théoriques, de 1857, sur la minceur du tympan, sur le style flexible et sur la couche semi-fluide. Mais il importe de remarquer que le célèbre américain parle le nez presque collé sur son tympan et que s'il se reculait de 50 à 80 centimètres seulement, sans l'addition d'un conduit acoustique, il n'obtiendrait aucune gravure appréciable." = "The result obtained in 1878 by Mr. Edison seems at first sight to contradict my ideas, a little exagerrated besides and very theoretical, in 1857, on the thinness of the tympanum, on the flexible stylus, and on the semi-fluid film. But it is important to observe that the celebrated American speaks nose nearly glued onto his tympanum, and that if he were to move back only 50 to 80 centimeters, without the addition of an acoustic conduit he would not obtain any appreciable engraving."
[51] 1878 text has "pour burin" = "for a graver."
[52] 1878 text inserts comma.

ORIGINAL	TRANSLATION
«Vous le voyez, Messieurs,[53] l'invention de la graphie du son et de sa fixation est pour ainsi dire consomée: il ne reste plus qu'à perfectionner et étendre le procédé, qu'à l'appliquer aux sciences et aux arts. Je n'insisterai point sur des expériences directes qui prouvent que tous les éléments de la voix passent par la membrane;[54] qu'avec les	"You see, gentlemen, the invention of the writing of sound and of its fixing is consummated, so to speak: nothing more remains than to perfect and extend the process, to apply it to the sciences and to the arts. I will not insist on the direct experiments which would prove that all the elements of the voice pass by the membrane;

[53] 1878 text lacks "Messieurs."

[54] 1878 text inserts endnote (pp. 71-2): "Il y a identité, ou à peu près, pour la conductibilité du son, **{72}** entre les membranes, les plaques et les cloisons. J'ai fait en 1857 l'expérience suivante que je retrouve dans une lettre inédite adressée à M. Pouillet. Il s'agissait de savoir dans quelles conditions l'ébranlement complexe de l'air qui constitue la parole peut passer intégralement à travers des milieux solides.

"«Une cloison de bois et de plâtre qui sépare deux chambres contiguës a été pour moi comme une sorte de membrane grossière ou plutôt de cloison membraneuse. Tous les éléments dynamiques du son qui traversent cette cloison devront a *fortiori* impressionner les membranes physiologiques. Quand mon oreille est placée à un mètre de distance de la cloison, une conversation à voix ordinaire d'une personne établie au milieu de la chambre voisine ne me parvient que sous la forme de son retentissement dans la masse d'air de la chambre.

"«A un centimètre de la séparation, mon oreille commence à discerner les tons, ainsi que les articulation les plus tranchées, mais le timbre est fortement altéré.

"«En appliquant l'oreille sur la cloison même, dans les meilleures conditions d'isolement du milieu extérieur, je distingue d'une manière complète les quatre éléments de la voix.

"«J'en conclus qu'une membrane ou plutôt qu'une cloison mince peut s'impressionner de tous les éléments de la voix aux conditions suivantes: proximité suffisante; tranquillité parfait de l'air; et pour certains d'entre eux (bruits de frôlement, etc.), de lui être amenés par une transmission dite de solides.

"«La nécessité d'un intermédiaire solide pour la transmission complète apparaît très-nettement dans les essais de palpation tactile du son. Un sourd-muet de mes amis palpe une membrane nue mise en vibration par ma voix, il n'éprouve qu'une perception obtuse du phénomène sonore. Si je lui fais toucher sur la même membrane une tigelle de sureau appliquée à son centre, cet intermédiaire solide lui procure une connaissance bien plus nette, bien plus précise, du mouvement vibratoire et de ses détails.»

"Il sera facile, dans le phonautographe perfectionné que je prépare, de faire suivre au sourd-muet qui sait lire l'exécution d'une dictée imprimée sur un tableau placé derrière l'opérateur, à la fois sur les lèvres de ce dernier par la vue et sur le tympan qui vibre, au moyen de la palpation tactile." =

"There is an identity, or nearly so, for the conductability of sound, between membranes, plates, and partitions. I made in 1857 the following experiment which I find in an unpublished letter addressed to M. Pouillet. It was a question of knowing under what conditions the complex agitation of the air which constitues speech can pass in full through solid media.

"'A partition of wood and of plaster which separates two contiguous rooms has been for me like a sort of crude membrane or, rather, membranous partition. All the dynamic elements of sound which traverse this partition must impress physiological membranes all the more. When my ear is placed a meter in distance from the partition, a conversation in a person's ordinary voice held in the environment of the neighboring room reaches me only in the form of its resonance in the mass of the room's air.

"'At a centimeter of separation, my ear begins to discern the pitches, as well as the most distinct articulations, but the timbre is strongly altered.

"'In applying the ear to the same partition, in better conditions of isolation from the exterior environment, I distinguish in a complete way the four elements of the voice.

"'I conclude therefrom that a membrane or rather a thin partition can be impressed by all the elements of the voice under the following conditions: sufficient proximity; perfect tranquillity of the air; and for certain ones among them (hissing noises, etc.), being brought forth from it by a said transmission of solids.

ORIGINAL	TRANSLATION

dispositions requises son mouvement est adéquat à celui du fluide sonore. Je ne dirai rien non plus de la forme et des dimensions de mon conduit auditif artificiel, de la préparation de la membrane mince, de la substance du style et de son mode d'application, du rôle de cet osselet de l'ouïe appelé le marteau. Ce sont là des questions sans aucun doute très-importantes dans la solution,[55] dans la pratique de cet art difficile; mais il serait trop long de les développer ici,[56] et je les réserve pour le mémoire complet dont je prépare en ce moment la rédaction. L'étude de ces différents organes de l'appareil phonautographique m'a couté des tâtonnements infinis. Je ne saurais, à vrai dire, les regretter: en comparant pas à pas les données d'un tel instrument aux moyens mis en œuvre dans l'oreille humaine, on est amené à des découvertes aussi curieuses qu'inattendues. C'est qu'à mon sens, Messieurs, l'appareil de l'audition est le meilleur et le plus complet des traités d'acoustique.

that with the required arrangements its motion is suitable for that of the sounding fluid. Neither will I say anything of the form and dimensions of my artificial auditory conduit, of the preparation of the thin membrane, of the substance of the stylus and of its method of application, of the role of that ossicle of the ear called the hammer. These are without any doubt very important questions in the solution, in the practice of this difficult art; but it would take too long to develop them here, and I am saving them for the complete account which I am currently preparing to compose. The study of these different organs of the phonautographic apparatus cost me infinite gropings.[57] I could not regret them, to tell the truth: in comparing step by step the ideas of such an instrument to the means implemented in the human ear, one is brought to discoveries as curious as unexpected. This is because to my mind, gentlemen, the apparatus of audition is the best and most complete of the treatises of acoustics.

«Je veux citer à la hâte quelques faits à l'appui de ce que j'avance.

"I want to cite in haste some facts in support of what I am advancing.

"'The necessity of a solid intermediary for complete transmission appears very clearly in tests of tactile feeling of sound. A deaf-mute among my friends feels a bare membrane set into vibration by my voice, he experiences only a blunt perception of the sounding phenomenon. If I have him touch upon the membrane an elder stem applied at its center, this solid intermediary gives him a very much clearer, very much more precise knowledge of the vibratory motion and of its details.'

"It will be easy, in the perfected phonautograph which I am preparing, to have the deaf-mute who knows how to read follow the performance of a dictation printed on a table placed behind the operator, at once on the lips of this last by sight and on the tympanum which vibrates by means of tactile feeling."

[55] 1878 text lacks "dans la solution."

[56] 1878 text lacks the remainder of this paragraph.

[57] *Tâtonnements*, in the metaphorical sense of "trial and error" attempts.

ORIGINAL	TRANSLATION
«Toute masse d'air comprise dans un espace limité a, comme on sait, un ton propre, dans lequel elle résonne plus facilement, plus fortement que dans tout autre. Dans un tuyau, c'est ce ton qu'on appelle le ton fondamental. Admettez que ce ton s'écrive d'une manière distincte de tous les autres tons, ce qui a lieu en effet; voilà un unisson fixe trouvé, un point de départ, sans intervention de l'oreille, pour l'accord entre les instruments et les voix.[58] C'est déjà une conquête, s'il est bien établi, comme on me l'assure, qu'une oreille délicate ne saurait déterminer avec certitude à quelle octave appartient un son donné[59] extrêmement grave ou extrêmement aigu. Dans notre oreille ce[60] ton fondamental, peu sensible d'ailleurs, grâce aux courbures du conduit qui rompent en partie l'unité de la masse d'air, est au-dessus du registre ordinaire des instruments et des voix; dans notre appareil phon-**{1878:44}**autographique, à grandes dimensions, il devra être au-dessous de ce registre.	"Any mass of air compressed in a limited space has, as one knows, a characteristic pitch at which it resonates more easily, more strongly than at any other. In a pipe, this is that pitch which one calls the fundamental pitch. Suppose that this pitch writes itself in a manner distinct from all other pitches, which does indeed take place; here is found a fixed unison, a point of departure, without the intervention of the ear, for the accord between instruments and voices. This is already a conquest, if it is well established, as I have been assured, that a delicate ear could not determine with certainty to which octave a given sound extremely low or extremely high belongs. In our ear this fundamental pitch—besides being not very appreciable, thanks to the curves of the conduit which break in part the unity of the mass of air—is above the ordinary register of instruments and voices; in our phonautographic apparatus of large dimensions, it must be below this register.
«La membrane du tympan a, comme je vous le disais, par rapport à l'axe du conduit auditif,[61] la plus forte inclinaison compatible avec sa bonne tension. Cette position joue, selon moi,[62] un rôle capital dans le phénomène de l'audition. Ainsi que Müller l'avait soupçonné, les membranes perpendiculaires au tuyau ne s'impressionnent que rarement et faiblement de l'onde dite d'inflexion.[63] Cette onde, Messieurs,[64] occupe la place la plus importante de beaucoup[65] dans la transmission de la voix par une membrane. J'ai l'honneur d'en mettre une figure sous vos yeux,[66] dans cette épreuve qui montre le tracé de l'oraison dominicale récitée d'une voix accentuée à cinquante centimètres de la membrane. Cette autre épreuve représente l'onde d'inflexion pendant une gamme cadencée de la voix. Müller, Messieurs,[67] expérimentateur[68] d'une admirable sagacité, professe depuis longtemps l'existence de cette sorte d'onde dans son *Manuel de Physiologie.*[69] Vous remarquerez dans mes	"The membrane of the tympanum has, as I told you, in relation to the axis of the auditory conduit, the greatest inclination compatible with its good tautness. This position plays, in my opinion, a capital role in the phenomenon of audition. As Müller suspected, the membranes perpendicular to the pipe are impressed only rarely and weakly by the wave called that of inflection. This wave, gentlemen, occupies by far the most important place in the transmission of the voice by a membrane. I have the honor of placing beneath your eyes a figure thereof in this print which shows the trace of the dominical oration [i.e., the Lord's Prayer] recited by an accentuated voice fifty centimeters from the membrane. This other print represents the wave of inflection during a rhythmic scale of the voice. Müller, gentlemen, an experimenter of admirable sagacity, has long professed the existence of this sort of wave in his *Manual of Physiology.* You will notice in my

[58] 1878 text begins new paragraph here.
[59] 1878 text lacks "donné."
[60] 1878 text has "le."
[61] 1878 text lacks comma.
[62] 1878 text has "Cette position, messieurs, joue" = "This position, gentlemen, plays."
[63] 1878 text italicizes "inflexion."
[64] 1878 text lacks "Messieurs."
[65] 1878 text has "la place de beaucoup la plus importante."
[66] 1878 text lacks comma.
[67] 1878 text does not capitalize "messieurs."
[68] 1878 text has "cet expérimentateur" = "that experimenter."
[69] 1878 text does not capitalize "*physiologie.*"

ORIGINAL	TRANSLATION

épreuves que ce second mouvement, cette crête longitudinale[70] qui parcourt la membrane d'une de ses bords[71] à l'autre, n'altère en rien l'onde de condensation, la vibration proprement dite;[72] elles coexistent,[73] et cette dernière ne cesse pas de marquer la tonalité, le timbre et, dans les cas ordinaires, l'intensité.[74] Ce que je revendiquerai donc pour ma part dans cette question, c'est d'avoir manifesté l'intervention de cette onde d'inflexion dans les mouvements de l'organe vocal autres que la vibration, dans les mouvements de totalité par exemple.

prints that this second motion, this longitudinal ridge which runs through the membrane from one of its edges to the other, does not distort in any way the wave of condensation, the vibration properly so called: they coexist and this last does not cease to mark the pitch, the timbre and, in ordinary cases, the intensity. What I will therefore assert for my part in this question is to have shown the intervention of this wave of inflection in the motions of the vocal body other than the vibration, in the motions of totality for example.

«J'ai dit que lorsqu'il s'agira de recueiller le son à une certaine distance, le conduit devra être impropre à vibrer. S'il était sonore,[75] les vibrations de la membrane deviendraient faibles; car à chaque transmission de fluide à solide elles perdent considérablement de leur amplitude. Cette circonstance de la mise en vibration du conduit par la voix, défavourable à la graphie de la parole et du chant,[76] nous fournit un[77] moyen d'écrire le mouvement moléculaire des bois, des métaux, des alliages, sous l'influence de sons fixes et déterminés. Nous pourrons acquérir ainsi la connaissance du mode de sonorité des corps dans ses rapports avec leur texture intime. Voici une planche qui[78] fournit une notion *de* **{1878:45}** *visu* sur le mouvement d'un tuyau de frêne sous l'influence de sons de la voix. Le style qui écrit a été placé directement sur le bois au lieu de l'être sur la membrane. Chacun des matériaux divers, des agents employés dans les arts, offrira de cette manière une graphie propre dont le caractère sera subordonné à la disposition de ses fibres, à son plus ou moins d' homogénéité,[79] à sa densité. Il y aura là, je l'espère, de belles découvertes à faire et des applications utiles à plusieurs industries. Mais l'heure me presse,[80] et je n'insiste pas davantage sur ce côté intéressant de mes recherches.

"I have said that when it is a matter of collecting sound at a certain distance, the conduit will need to be unsuited to vibrating. If it were sounding, the vibrations of the membrane would become weak; because in every transmission from fluid to solid they lose considerably in their amplitude. This circumstance of the setting into vibration of the conduit by the voice, unfavorable to the writing of speech and song, furnishes us a means of writing the molecular motion of woods, metals, alloys, under the influence of fixed and determined sounds. We could thus acquire knowledge of the method of sounding of bodies with respect to their inmost texture. Here is a plate which furnishes an idea by sight of the motion of an ashen pipe under the influence of sounds of the voice. The stylus which writes has been placed directly upon the wood instead of being upon the membrane. All the divers materials, the agents employed in the arts, will offer in this manner a characteristic writing of which the character will depend on the arrangement of its fibers, on its greater or lesser homogeneity, on its density. There will be, I hope, grand discoveries to be made and applications useful to several industries. But the hour presses me and I do not insist further upon this interesting side of my research.

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[70] 1878 text has "que l'existence de ce second mouvement, de cette crête longitudinale" = "that the existence of this second motion, of this longitudinal ridge."
[71] 1878 text has "extrémités" = "ends."
[72] 1878 text has colon for semicolon.
[73] 1878 text lacks comma.
[74] 1878 text lacks remainder of paragraph and inserts endnote S (p. 72): "J'écrivais, avec ce premier appareil, en me servant de membranes minces et faiblement tendues, ce qui explique l'apparence singulière que revêt quelquefois cette onde d'inflexion." = "I wrote, with this first apparatus, in availing myself of membranes thin and weakly stretched, that which explains the singular appearance which this wave of inflection sometimes takes on."
[75] 1878 text lacks comma.
[76] 1878 text lacks "défavourable à la graphie de la parole et du chant." The word "défavourable" is impossible to read with certainty in our copy of the 1857 imprint, but this is the most plausible reading that also matches the translation "unfavorable" in the *Photographic News.*
[77] 1878 text has "le."
[78] 1878 text "Une de mes planches" = "One of my plates."
[79] 1878 text has "à son homogénéité plus ou moins parfaite" = "on its more or less perfect homogeneity."
[80] 1878 text lacks comma.

ORIGINAL	TRANSLATION
«Je ne saurais, Messieurs,[81] traiter ici incidemment et à la hâte la question **{1857:[3]}** du timbre: c'est[82] un champ trop neuf, trop fécond, pour qu'on ne soit pas tenté d'en faire l'objet d'un travail complet et approfondi. J'ai réuni un certain nombre d'épreuves présentant les sons de la voix comparés à ceux du cornet à piston, du hautbois et d'une grande membrane de caoutchouc rendant des sons très-graves. Les instruments, comme on pouvait le pressentir, se distinguent d'avec les voix par les caractères de la vibration. Je vous soumettrai quelques épreuves de ce genre dans une prochaine séance. Voici le tracé de cris explosifs, de hurlements comparés avec le chant. Je crois avoir constaté ce fait curieux[83] que le son d'un instrument, d'une voix,[84] donne une suite de vibrations d'autant plus régulières, plus égales, et par conséquent plus isochrones, qu'il est plus pur pour l'oreille, mieux filé; dans le cri déchirant, dans les sons aigres des instruments, les ondes de condensation sont irrégulières, inégales, non isochrones. On pourrait presque dire qu'il y a , à ce point de vue, des sons faux et[85] discords d'une façon absolue. Voici un autre aspect de la question du timbre; c'est une planche qui montre les mauvais sons de la voix, les sons voilés. Avec un peu d'attention vous apercevrez une, quelquefois[86] deux et même trois vibrations secondaires combinées avec l'onde principale.	"I would not know, gentlemen, how here to treat incidentally and in haste the question of timbre: this is a field too new, too fertile, for one not to be tempted to make thereof the subject of a complete and thorough work.[87] I have gathered together a certain number of prints showing the sounds of the voice compared to those of the cornet, of the oboe, and of a large membrane of rubber producing very low sounds. The instruments, as one might imagine, distinguish themselves from the voices by the characters of the vibration. I will submit to you some prints of this kind in an upcoming session. Here is the trace of explosive cries, of yells compared with singing. I believe I have noted the curious fact that the sound of an instrument, of a voice, gives a series of vibrations the more regular, more even, and in consequence more isochronous, the more pure it is for the ear, the better held;[88] in the heart-rending cry, in the sour sounds of instruments, the waves of condensation are irregular, uneven, not isochronous. One could almost say that there are, from this point of view, false and discordant[89] sounds in an absolute way. Here is another aspect of the question of timbre; this is a plate that shows the bad sounds of the voice, the husky sounds. With a little attention you will see one, sometimes two and even three secondary vibrations combined with the principal wave.
«La facilité d'écartement,[90] presque indéfinie des molécules de **{1878:46}** la couche semi-fluide nous[91] permettra d'étendre nos[92] investigations et d'obtenir avec facilité le tracé des mouvements les plus subtils, les plus délicats, autres que le mouvement sonore. Tels sont ceux du pendule à fil, de l'aiguille aimantée, des vibrations dus à l'élasticité, à	"The almost unlimited facility of displacement of the molecules of the semi-fluid film will permit us to extend our investigations and to acquire with ease the trace of the subtlest, most delicate motions, other than sonorous motion. Such are those of the wire pendulum, of the magnetic needle, of the vibrations due to elasticity, to

[81] 1878 does not capitalize "messieurs."
[82] 1878 text has "timbre. C'est...."
[83] 1878 text inserts comma.
[84] 1878 text has "qu'un son, soit d'un instrument, soit d'une voix" = "that a sound, be it of an instrument or of a voice."
[85] 1878 text lacks "faux et."
[86] 1878 text has "une et quelquefois."
[87] The *Photographic News* text substitutes, as a one-sentence paragraph: "Phonautography reproduces not only the *tone* of the sound, it also represents in its way, the *pitch*."
[88] I assume this is the sense of *filé* Scott has in mind here, as in the "holding" of a musical note. The *Photographic News* has "better heard."
[89] Both adjectives can also be translated "out of tune."
[90] 1878 text lacks comma.
[91] 1878 text lacks "nous."
[92] 1878 text has "les."

ORIGINAL	TRANSLATION

la torsion.[93] Voici comme spécimen de ce genre d'études, dont le champ me paraît devoir être assez vaste, le tracé d'un mouvement curieux en physique: c'est celui[94] d'un toton d'acier qui descend lentement un plan incliné en se balançant sur son axe. Le nombre de ses tours et le mouvement de libration sont nettement marqués. [95] Dans une autre séance je mettrai sous vos yeux la graphie de différentes explosions et de bruits rapides; vous verrez qu'il est facile d'apprécier, de mesurer par nos moyens leur succession, leur caractère, leurs intensités relatives.

torsion. Here as a specimen of this kind of studies, of which it seems to me the field must be quite vast, is the trace of a motion curious in physics: it is that of a steel teetotum which slowly descends an inclined plane while balancing itself on its axis. The number of its turns and the motion of libration are clearly marked. In another session I will place before your eyes the writing of different outbursts and of rapid noises; you will see that it is easy to appreciate, to measure by this means their succession, their character, their relative intensities.

«Vous le voyez donc, Messieurs,[96] voici[97] un art graphique tout nouveau qui surgit des entrailles de la physique, de la physiologie, de la mécanique. Des hommes aussi expérimentés que vous, et si bien au courant de l'histoire des découvertes contemporaines, me dispenseront,[98] je l'espère, de répondre à la banale objection: «*A quoi bon?*» toujours prête a saluer une invention naissante. Il est pourtant une question que je prévois et à laquelle je désire répondre avec netteté avant de finir. Êtes-vous en mesure, me dira-t-on, de donner, sans appareil coûteux, sans nouveaux essais, une sténographie naturelle, immédiatement traduisible, du discourse, de l'improvisation? Non, Messieurs, et[99] voici pourquoi: Le[100] tracé de la parole, encore incomplet d'ailleurs, que je vous soumets[101] en ce moment est l'analyse des éléments de la voix parlée; il est, pour me servir d'une expression des mathématiciens, fonction de la tonalité, de l'intensité, du timbre; il n'est donc pas la synthèse de la parole, ni, à plus forte raison, un signe de pure convention, comme l'écriture, qui n'a, qu'on ne l'oublie pas, aucune

"So you see, gentlemen, here is an entirely new graphic art which springs from the heart of physics, physiology, mechanics. Men as experienced as you, and so well acquainted with the history of contemporary discoveries, will excuse me, I hope, from responding to the banal objection: 'To what good?' always ready to greet a nascent invention. It is, however, a question which I foresee and to which I wish to respond with clarity before finishing. Are you in a position—one will say to me—to give, without costly apparatus, without new trials, a natural stenography, immediately translatable, of speech, of improvisation? No, gentlemen, and here is why: besides being still incomplete, the trace of speech which I submit to you at this moment is the analysis of the elements of the speaking voice; it is, to avail myself of an expression of mathematicians, a function of the pitch, of the intensity, of the timbre; it is not therefore the synthesis of speech, much less a sign of pure convention like writing, which has—lest one forget[108]—no

[93] 1878 text continues preceding sentence: "les mouvements, par exemple, du pendule, de l'aiguille aimantée, des vibrations dues à l'élasticité, à la torsion" = "the motions, for example, of the pendulum, of the magnetic needle, of the vibrations due to elasticity, to torsion."
[94] 1878 text has "Voici comme spécimen de ce genre d'études, dont le champ me paraît devoir être assez vaste, je montre le tracé d'un mouvement curieux en physique, celui...." = "As a specimen of this kind of studies, of which it seems to me the field must be quite vast, I show the trace of a motion curious in physics, that...."
[95] 1878 text concludes this paragraph with "Les essais de graphie de différentes explosions et des bruits rapides prouvent qu'il est facile d'apprécier, de mesurer par ce moyen leur succession, leur caractère, leur intensités relatives" = "The attempts at the writing of different outbursts and rapid noises prove that it is easy to appreciate, to measure by this means their succession, their character, their relative intensities."
[96] 1878 text omits "Vous le voyez donc, Messieurs."
[97] 1878 text inserts "donc" = "thus."
[98] 1878 text has "On me dispensera" = "One will excuse me...."
[99] 1878 text has "Non. Et...."
[100] 1878 text does not capitalize "le."
[101] 1878 text has "possède" = "possess."

ORIGINAL	TRANSLATION

réalité phénoménale, aucune base objective. [102] Cette synthèse, néanmoins, je la crois possible et je me propose de la tenter; permettez-moi d'ajouter que j'en possède les moyens.[103] Mais, Messieurs,[104] de grandes obscurités pèsent encore sur l'histoire de la voix articulée;[105] quand nous saurons nettement ce qu'elle est, après une étude complète de chacun de ses éléments par nos procédés, nous transformerons par des moyens mécani-**{1878:47}**ques, le tracé des mots en une suite de signes. Je préférerais marcher en ce moment du simple au composé et réaliser la sténographie du chant et des instruments, qui sera facile avec un moteur à mouvement uniforme. Je sollicite, Messieurs,[106] les conseils des hommes compétents pour m'aider à préparer des membranes plus sensibles, moins hygroscopiques, plus rapprochées des membranes physiologiques, que celles usitées dans le commerce; car, vous le savez, l'industrie n'offre pas tout disposés les matériaux indispensables à des applications imprévues. Je profiterai bien volontiers aussi des indications des praticiens spéciaux pour les questions de renforcement du son,[107] qui se présentent comme une nécessité dans la graphie de la parole.

phenomenal reality, no objective basis. Nevertheless, I believe this synthesis possible, and I propose to attempt it; allow me to add that I possess the means thereof. But, gentlemen, some great obscurities still weigh upon the history of the articulated voice; when we know clearly what this is, after a complete study of each of its elements by our processes, we will transform by mechanical means the trace of the words into a series of signs. I would rather proceed at present from the simple to the compound and achieve the stenography of song and of instruments, which will be easy with a motor of uniform motion. I solicit, gentlemen, the counsels of men competent to aid me in preparing more sensitive, less hygroscopic membranes, closer to the physiological membranes than those used in commerce; because, you know, industry does not offer fully prepared the materials indispensable to unforeseen applications. I will gladly profit also from the information of special practitioners on the questions of reinforcement of sound which present themselves as a necessity in the writing of speech.

«Il y a, Messieurs,[109] je n'ai pas l'intention de le dissimuler, de nombreux précédents dans la carrière où je suis entré. Je ne saurais sans trop de développements en tracer un historique convenable. Je me contenterai de citer les noms de Félix Savart, de Jean Müller, de M. Duhamel, de M. Arthur Morin, de M. Wertheim, de M. Pouillet, de M. Lissajous. Ces[110] essais, imparfaits encore, que je vous présente,[111] me feront-ils pardonner d'avoir osé m'engager sur le sillon fécondé par de tels maîtres?

"There is, gentlemen—I have no intention of concealing it—a number of precedents in the course where I have entered. I would not know how, without too many dilations, to trace a suitable history thereof. I will content myself with citing the names of Félix Savart, Jean Müller, M. Duhamel, M. Arthur Morin, M. Wertheim, M. Pouillet, M. Lissajous. Will these attempts, still imperfect, which I present to you, help pardon me for having dared enter upon the furrow rendered fertile by such masters?[112]

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[102] 1878 text lacks "aucune base objective."
[103] 1878 text lacks "permettez-moi d'ajouter que j'en possède les moyens."
[104] 1878 text lacks "Messieurs."
[105] 1878 text begins new sentence here.
[106] 1878 text lacks "Messieurs."
[107] 1878 text lacks comma.
[108] Literally "that one might not forget it."
[109] 1878 text does not capitalize "messieurs."
[110] 1878 text has "Les."
[111] 1878 text lacks comma.
[112] The text quoted in the *Photographic News* concludes here with a final sentence added to this paragraph: "I hope so, for I have already advanced much farther than they, perhaps, would have dared to prophesy." For Moigno's concluding remarks, see the facsimile at the end of this document.

ORIGINAL	TRANSLATION
«Je saisis l'occasion de témoigner ma profonde reconnaissance envers M. Pouillet de l'Institut[113] et trois de vos membres,[114] MM. Barreswil, Ant.[115] Masson et Barral,[116] qui m'ont donné des marques précieuses de leur bienveillante sympathie.	I seize the occasion to show my profound gratitude towards M. Pouillet of the Institute and three of your members, Messrs. Barreswil, Ant. Masson and Barral, who have given me precious tokens of their kindly sympathy.
«Je termine. Puisse-je, Messieurs, n'avoir épuisé votre indulgente attention, tout en n'esquissant qu'à grands traits des travaux poursuivis depuis plusieurs années. Mon seul titre à votre faveur, c'est une conviction ferme, une persévérance constante. En voyant le livre de la nature ouvert aux regards de tous les hommes, j'ai cru pouvoir essayer d'y lire. La tâche que je me suis donnée, je le sens, est lourde pour ma faiblesse: tout ce qu'il reste à faire, je ne saurais l'accomplir seul. Le peu que j'ai réalisé, ce que j'entrevois encore, vous daignerez l'examiner, Messieurs; et si vous partagez une partie de mes espérances, veuillez vous rappeler qu'en vous consacrent ces prémices je suis venu vous dire: «Aidez-moi!»[117]	"I conclude. May I not have exhausted your indulgent attention, gentlemen, while sketching only in broad strokes the work pursued for several years. My only claim to your favor is a firm conviction, a constant perseverence. Seeing the book of nature opened before the gaze of all men, I believed I could try to read therein. The task I have set myself is, I sense, heavy for my weakness: I do not know how to accomplish alone all that remains to be done. Condescend to examine, gentlemen, the little which I have achieved, what I still foresee; and if you share a little in my aspirations, be so good as to remember that in dedicating to you these first steps I came to say to you: "Help me!"

[113] 1878 text sets "de l'Institut" off in commas.
[114] 1878 text omits comma.
[115] 1878 text has "Antoine."
[116] 1878 text omits comma.
[117] 1878 text contains a paragraph similar in content but worded very differently: "«J'ai terminé, messieurs, et quoique je craigne d'avoir épuisé votre indulgente attention, je n'ai pu qu'esquisser à grands traits l'ensemble des travaux que je poursuis depuis plusieurs années. Je n'ai encore d'autres titres à votre faveur qu'une conviction inébranlable. J'ai vu le livre de la nature ouvert devant le regard de tous les hommes et, si peu que je sois, j'ai cru qu'il me serait permis de vouloir y tire. Mais je sens que la carrière est longue; la tâche que je me suis donnée est lourde pour ma faiblesse. Je ne saurais accomplir seul ce qu'il y a à faire. Examinez, **{1878:48}** messieurs, ce que j'ai déjà réalisé, ce que je me propose de faire et, si vous partagez un peu de mes espérances, daignez vous souvenir que je suis venu vous dire: aidez-moi.»" = "I have finished, gentlemen, and though I fear I have exhausted your indulgent attention, I have been able only to sketch in broad strokes the whole of the work which I have been pursuing for several years. I lay no claim to your favor yet than an unshakable conviction. I saw the book of nature opened before the gaze of all men and, however little I may be, I believed it would be permitted me to want to draw therein. But I sense that the course is long; the task I have set myself is heavy for my weakness. I do not know how to accomplish alone what there is to be done. Examine, gentlemen, what I have already achieved, what I propose to do; and if you share a little in my aspirations, deign to remember that I came to say to you: help me."

ORIGINAL	TRANSLATION
M. le président.[118]—Monsieur Scott, avez-vous fait acte de possession de vos procédés par quelque publication? Avez-vous des appareils?	*Mr. President.*—Monsieur Scott, have you exercised an act of possession of your processes by some publication? Do you have an apparatus?
M. Léon Scott.—Il y a quatre ans, j'ai fait une première expérience chez un musicien distingué[119] avec l'assistance de quelques amis; j'ai[120] déposé un paquet cacheté descriptif à l'Institut[121] au mois de janvier dernier;[122] ce paquet contient des épreuves authentiques[123] faites il y a quatre ans. M. le vicomte du Moncel a bien voulu faire connaître dans les journaux mes premiers résultats au printemps dernier; le 25 mars j'ai pris[124] un brevet d'invention avec les fonds et sous les auspices de la Société d'encouragement;[125] depuis, j'ai déposé à cette même Société de nouveaux paquets cachetés.[126] Je crois être parfaitement en règle quant à la priorité de l'invention. Les expériences que j'ai eu l'honneur de vous soumettre ont été faites avec des appareils en bois, en carton, en plâtre, que j'ai construits de mes mains.[127] Tout imparfaits qu'ils soient, je pourrais, si vous le jugez utile, Messieurs, les faire fonctionner devant vous.	*M. Léon Scott.*—Four years ago, I made a first experiment at the house of a distinguished musician with the assistance of some friends; I deposited a sealed descriptive packet at the Institute in the month of January last; this packet contains authentic prints made four years ago. The Viscount du Moncel was so kind as to make my first results known in the journals last spring; on 25 March, I obtained a patent of invention with the funds and under the auspices of the Society of Encouragement; I have since deposited with this same Society some new sealed packets. I believe myself to be perfectly in order as to the priority of the invention. The experiments which I have had the honor of submitting to you were made with apparatuses of wood, of cardboard, of plaster, which I built with my [own] hands. Very imperfect though they may be, I could—if you deem it useful, gentlemen—operate them before you.
Paris, le 28 octobre 1857.	Paris, 28 October 1857.

[118] 1878 text capitalizes "President."
[119] 1878 text has "musicien connu" = "known musician."
[120] 1878 text capitalizes "J'ai."
[121] 1878 text inserts comma.
[122] 1878 text begins new sentence here.
[123] 1878 text lacks "authentiques."
[124] 1878 text starts new sentence: "J'ai pris le 25 mars...."
[125] 1878 text capitalizes "Encouragement."
[126] 1878 text has "depuis j'ai déposé de nouveaux paquets cachetés à cette même Société" = "I have since deposited new sealed packets with this same Society."
[127] 1878 text concludes here with "J'ai des appareils des appareils en bois, en carton, en plâtre, que j'ai construits de mes mains et avec lesquels j'ai fait les expériences que j'ai l'honneur de vous soumettre" = "I have apparatuses of wood, of cardboard, of plaster, which I built with my [own] hands and with which I made the experiments that I have the honor of submitting to you."

((((First Sounds))))

APPENDIX

FACSIMILE OF
THE PHOTOGRAPHIC NEWS
15 APRIL 1859
PP. 62–4

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photographic purposes being difficult, and subject to numerous accidents. The process I propose is of extreme simplicity, very economical, and it yields proofs of very great delicacy, at the same time that it is very rapid in its action, especially the first method."

THE NEW ACTION OF LIGHT.

BY M. NIÈPCE DE ST. VICTOR.

THE following is the note referred to by our Paris correspondent, in his letter of the 5th inst., as about to be published in *Cosmos*:—

"To obtain the conviction that there is really an action of light when a sheet of sensitised paper is covered with a tube containing a piece of insolated cardboard, it is only necessary to make the following experiment:—Take a sheet of Bristol board and from it cut two pieces of equal size; put one of these pieces round the inside of a tube without insolation, and after insolating the other, line a precisely similar tube with it, and invert the two tubes over negatives (formed, say, of large printed letters) placed on the same sheet of sensitised paper, and leave them in a dark and cool place for twenty-four hours; after which time the sensitive paper must be dipped in gallic acid, and it will be seen which is the most vigorous image; if neither of the substances used has received the slightest influence from the action of the light, no image will be visible on that part of the paper which was covered with the tube containing the non-insolated cardboard.

"If the insolated cardboard had been properly impregnated with tartaric acid or a salt of uranium, the action of the light would have been all the stronger on the sensitised paper; but I must not omit to state that the solutions of tartaric acid and salt of uranium must not be too concentrated, because in this case crystallisation is produced on the paper which hinders the action of the light; also, that a too prolonged exposure to the light causes a diminution rather than an augmentation of activity; it in some way becomes weaker after attaining its maximum of intensity.

"I may observe, also, that the same result which I have pointed out as following on the inversion of the tubes for twenty-four hours may be obtained in ten minutes; to accomplish this, it is only necessary to slightly moisten the cardboard and heat it to a temperature of from 120 to 140 degrees, but not higher, for at 212 degrees, or even less, there is an action of heat which produces the same effect as light. But these two essentially distinct actions must not be confounded, although they may produce themselves simultaneously.

"In a word — the more the cardboard is impregnated with substance and insolated (without, however, exceeding certain limits), the more activity it acquires. Hitherto I have obtained the maximum of activity by means of tartaric acid.

"The nature of the size used for the paper or cardboard often suffices to make it acquire considerable activity.

"Now, if Mr. Crookes repeats his experiment of the cardboard impregnated with tartaric acid (non-insolated) without heating his tube, he will certainly not have any action; but if he operates comparatively with an insolated cardboard, he will have an impression which will be all the stronger as the operation shall have been continued a greater length of time; for the activity is very far from being totally liberated in twenty-four hours, if the operation be conducted dry and at a low temperature.

"Humidity, and a heat of from 120 to 140 degrees, speedily liberates this activity; but care must be taken to avoid raising the temperature to 212 degrees, because in this case there is an action of heat which acts chemically on certain papers sensitive to the action of light, and equally so to heat, as are all papers that are acid.

"For the rest, the best means of distinguishing the action of light is to take a paper insensible to heat, but remaining sensitive to light, as one prepared with an alkaline salt of silver."

PHONAUTOGRAPHY; OR, THE GRAPHIC FIXING OF THE VOICE.

WE have already briefly referred to the curious essays of M. Leon Scott, and we believe it will be of interest to our readers if we allow the inventor, naturally enthusiastic, to develop the happy idea he has conceived at greater length.

"Sound, as well as light, gives a durable picture at a distance; the human voice being able to record itself, in the manner proper to acoustics, on a sensitive surface; and after long efforts, I have been enabled to collect the tracings of all the movements of the air which constitute sounds, or noises; in fact, the same means have enabled me to obtain, under certain conditions, a faithful representation of rapid movements—of movements inappreciable to our senses from their smallness, and of molecular movements.

"It is a plan, as you see, by this new art, of forcing nature herself to constitute a written general language of all sounds.

"When the idea first occurred to me, more than four years ago, of fixing on a sensitive surface the trace of the movement of the air during singing or speaking, most of those to whom I confided my idea treated it as a chimera. The word did not appear to me to prove anything; it is the ordinary reception of the most sublime conquests of human intelligence, and my weak efforts have that in common with many great discoveries which in their cradle have been treated as utopian. I must admit, nevertheless, that this summary judgment was not without some appearance of reason. What is speech, in fact? A progressive movement of the air which surrounds us, induced by the play of our organs; but a very complex and infinitely delicate movement. This delicacy is such, that if you speak in a darkened room, in which only a single ray of sunshine is allowed to penetrate, the finest particles of dust in suspension, visible only in the luminous space, will not be agitated in a sensible degree. On the other hand, this subtile movement is exceedingly rapid. While one is speaking in an ordinary tone of voice, more than six hundred of these invisible movements of the air succeed each other in the short interval which intervenes between two strokes of the pulse, that is to say, a second.

"How, then, to succeed in fixing a clear, precise, complete trace of such a movement, incapable of agitating even one of our eyelashes? Ah! if I could only fix a pen or style on that air which surrounds one, and which receives all the elements of a sound, this pen, this style would form a trace on an appropriate fluid film. . . . . But where find a point of support? . . . To fix a pen on this fugitive, impalpable, invisible fluid, is a chimera, is impossible!

"This apparently insoluble problem is, however, solved somewhere. Let us attentively consider that marvel of marvels, the human ear. I say that our problem is solved in the phenomenon of hearing, and that the contrivances employed in the structure of the ear ought to lead us to the object sought. I don't just now pretend to make an incursion into the domains of the physiologist, but I must seek for what I require in the place where it is to be found. I have, besides, no necessity for any new theory on the organ of hearing, or on the manner in which it acts.

"This point found, the thing becomes one of rare simplicity. First of all, what do we see in the ear? A conduit. But what is a conduit? At the commencement of this century, on a calm night, M. Biot held a conversation in a low tone of voice, in whispers in fact, with another individual who was stationed at the other extremity of a tube made of brass, and which was 1,000 yards in length. Hence, in a conduit of any length whatever, properly isolated from all external movements, from all agitation of the strata of atmosphere,

the feeblest murmur of the voice is transmitted integrally to any distance. The conduit conducts, without alteration or diminution, the sonorous wave, complex as it may be, from one of the extremities to the other, by preserving it from all accidental causes which might disturb it; and if the conduit is in itself incapable of vibration, if no loss of the vibratory movement is accomplished on the journey, the wave will pursue indefinitely its primitive movement with the original purity, sharpness, and intensity. Such is, in acoustics, the part performed by a conduit in presence of a fluid in movement. I take note of this to obtain the autograph of sound at any distance. The conduit once found, I take possession of it and fashion it into a sort of funnel to concentrate the sounds towards its lesser extremity.

"Let us pursue our examination of the ear. At the end of the external auditory conduit, we encounter a thin membrane, tympanised and inclined. This membrane, according to the just definition of Müller, is a something half solid, half fluid; it partakes of the one by its coherence, of the other by the extreme facility of the displacement of all its molecules. It is the medium employed by nature for the transmission, as perfectly as possible, of the movement of a fluid to a solid. In the construction of the ear the divine artist has employed three membranes. We have just now seen that the sound of the voice does not sensibly agitate the dust suspended in space; yet we see that at a distance of more than ten yards, in a quiet room, during the night, the voice causes sand sprinkled on the surface of a membrane, stretched over a glass, to dance up and down energetically.

"We grasp now, in all its lucidity, the luminous thread which is to guide us; this support of our pen on the fluid in movement, which I asked for but a little while ago, is found; it is the thin membrane which we place at the extremity of our artificial auditory conduit.

"I have remarked that it was necessary, for the integral solution of the problem, that the style which was applied to fluid in motion, or, which comes to the same thing, on the membrane, should mark its trace on a second fluid. Indeed, any mode of inscription which should require an appreciable force would be impossible for our quasi aerial pen. It followed, therefore, that our sensitive surface must be fluid, in order that it might not offer any resistance to our delicate imprints. Well, just as we have taken a semi-solid for a pen, we shall take a semi-fluid for a matrix: this shall be lamp-black obtained from the smoke of burning bodies. A thin film deposited in a semi-fluid state, on any body whatever (metal, wood, paper, or tissue), and animated by an uniform movement of progression, in order that the traces formed shall not impinge the one on the other, such shall be our daguerrean plate, or rather our negative, capable of giving, by known means, thousands of proofs.

"You see the invention of the autography of sound and its fixation is, so to speak, consummated; it only remains to improve and extend the process, to apply it to science and the arts. I will not insist on the direct experiments which prove that all the elements of the voice pass by the membrane; that, with the requisite dispositions, its movement is adequate to that of the sonorous fluid. I will say nothing either of the form and dimensions of my artificial auditory conduit, of the preparation of the thin membrane, of the substance of the style and its mode of application; of the part performed by what is called the hammer. These are questions which are, without doubt, very important in the practice of this difficult art; but it would take too long to develop them here.

"I will hastily quote one or two facts in support of what I advance:—

"Every mass of air comprised within a limited space has, as is known, a proper tone, in which it resounds more easily and strongly than in any other. In a pipe it is this tone which is called the fundamental tone. Admit that this tone records itself in a manner distinct from all other tones—which is, in fact, the case—and there is a fixed unison found, a point of departure, without the intervention of the ear, for the accord between the instruments and the voices.

"I have observed that when it is a question of gathering sound at a certain distance, the conduit ought to be of a substance that will not vibrate. If it were sonorous, the vibrations of the membrane would become feeble; for at each transmission from a fluid to a solid they lose a considerable part of their amplitude. This circumstance of the vibration of the conduit caused by the voice, unfavourable to the autography of speech and song, furnishes us a means of recording the molecular movement of woods, metals, or alloys, under the influence of fixed and determined sounds; we might thus be able to acquire a knowledge of the mode of sonorousness of bodies in relation to their intimate texture. One of my plates yielded a notion *de visu* on the movement of a pipe made of ash wood under the influence of sounds and the voice. The style which wrote was placed directly on the wood instead of on the membrane. Each of the different materials employed in the arts, will give in this way a distinct *autograph*, the character of which will be subordinate to the disposition of its fibres, to its more or less perfect homogeneity, and its density. This opens the road, I hope, to some grand discoveries, as well as to useful applications to several manufactures.

"Phonautography reproduces not only the *tone* of the sound, it also represents in its way, the *pitch*.

"I have collected a certain number of proofs presenting the sounds of the voice compared with those of the cornet-à-piston, the hautboy, and of a large caoutchouc membrane, giving very grave sounds. The instruments, as might be imagined, distinguished themselves from the voice by the characters of the vibration. The traces of shouts or howling are clearly distinct from those of singing. I have been able to verify this curious fact, that the sound of an instrument, or a voice, gives a series of vibrations as much more regular and equal, and consequently more isochronous, as it is more pure to the ear, better heard; in the shriek, in the sharp sounds of instruments, the waves of condensation are irregular, unequal, non-isochronous. One might almost affirm that there are from this point of view, discordant sounds of an absolute form. Here is another aspect of the question of the *pitch*: it is a plate which shows the bad sounds of the voice—sounds that are not clear and sharp. With a little attention one may perceive, sometimes, two and even three secondary vibrations combined with the principal wave.

"The almost indefinite facility of separation of the molecules of the semi-fluid film will permit the extension of the investigations, and to obtain with ease the trace of the most subtle and delicate movements, other than the sonorous movements—the movements, for example, of the pendulum, of the magnetic needle, of the vibrations due to elasticity, or to torsion. As a specimen of this kind of study, the field of which appears to me sufficiently extensive, I show the trace of a movement singular in physics; that of a steel teetotum which slowly descends an inclined plane balancing itself on its axis. The number of its revolutions and the movement of libration are clearly marked. The attempts of producing the autographs of different explosions and quick noises, prove that it is easy to appreciate and measure, by this means, their succession, their character, and their relative intensities.

"Here is, then, a perfectly new graphic art which springs from physics, physiology, and mechanics. I shall, I hope, be excused from replying to the commonplace objection, '*What is the use of it?*'—always ready to salute a budding invention. It is, however, a question that I foresee, and to which I desire to respond with distinctness before I finish. Are you in a position, they will say to me, to give, without costly apparatus, without fresh essays, a natural stenograph, capable of immediate translation, of a speech? No. And this is the reason why the tracing of the words, which I possess at this moment, besides being incomplete, is but the analysis of the elements of the spoken voice; it is, to use an

expression of mathematicians, a function of the tone, intensity, and the pitch. It is not, then, a true synthesis of the word, nor, with greater reason, a purely conventional sign, like writing, which has, let us remember, no phenomenal reality. This synthesis, nevertheless, I believe possible, and I propose to attempt it. But great obscurity still weighs on the history of the articulated voice; when we know precisely what it is, after a complete study of each of its elements by our processes, we shall transform, by mechanical means, the tracing of the words into a succession of signs. I shall prefer, at this moment, to proceed from the simple to the compound, and to realise the stenography of singing and instruments, which will be easy, with a motive power of a uniform movement. I solicit the advice of men competent to assist me in preparing a more sensitive membrane, less hygroscopic, more approaching to the physiological membranes, than those used in commerce; for, as you are aware, commerce does not keep ready prepared the materials indispensable to unforeseen applications. I shall very willingly profit, also, by the suggestions of practical men as regards the question of reinforcement of the sound which presents itself, as a necessity, in the autography of spoken words.

"There are, I have no intention of concealing it, numerous precedents in the career on which I have entered. I could not, without too many digressions, trace a historical summary. I shall content myself with citing the names of Felix Savart, Jean Müller, MM. Duhamel, Arthur Morin, Pouillet, Wertheim, and Lissajous. Will these imperfect essays I have produced, procure my pardon for having dared to enter upon the ground trodden by such masters? I hope so, for I have already advanced much farther than they, perhaps, would have dared to prophesy."

We are happy to be able to announce that at this moment, M. Leon Scott, aided by the theoretical and practical ability of M. Rudolphe Kœnig, has just manufactured a new apparatus which registers with the greatest clearness the vibrations of a diapason even if they be of the number of a thousand a second. The registration on lines widely separated continues during twenty-four seconds; and the apparatus is in relation with one of M. Redier's chronometers, which divides this interval of twenty-four seconds into four intervals of six seconds each. We may, then, by a single experiment, count the number of vibrations of a given diapason, and make by simple tentatives that this number shall be rigorously equal to a given number: 870 for example. The problem of the diapasons and standard instruments, proposed by the Ministerial decision of the 1st of February, 1859, finds thus its easy and complete solution, and it seems to us impossible that this solution should not be immediately adopted.

We have also seen all the plates of which M. Scott speaks in his note—the tracery of simple sounds, compound sounds, chords of a prayer recited, a phrase declaimed, vibratory and gyratory movements of bodies animated, with, at the same time, a movement of transmission and rotation, &c., and we have found them truly surprising. We desired that they should be seen by Professor Wheatstone, who has himself done so much that is interesting in acoustics, and, like us, he found these essays of great promise for the future. He even undertook to bring the matter before the Royal Society of London. It is, therefore, with great confidence that we initiate our readers in the knowledge of this advance in the path of progress.

F. Moigno.

GOLD TONING PROCESS.

BY M. LE GRAY.

I have learnt that since the publication of my process of fixing positive proofs by chloride of lime and neutral chloride of gold, many persons have employed the process without obtaining as satisfactory results as those I obtained myself. This has arisen, I believe, in the first place, from want of habit, and experience of the force of the bath I have suggested, which, acting very energetically, does not allow of the action being followed without constant attention, and, consequently, it is very difficult to seize the exact moment when the proof ought to be withdrawn from the bath. By employing the following formula the progress of the operation will be much slower, and, consequently, more easy to follow:—

Distilled water	2,000 parts.
Chloride of lime	1 ,,
Chloride of gold	1 ,,
Chloride of sodium	1 ,,

The proof may remain in this bath for half an hour without detriment; the toning proceeding so slowly it is easy to arrest it at the moment it has acquired the desired depth.

I would observe that a bath of two litres, or quarts, containing only a very small proportion of chloride of gold, can only be efficacious in the case of about a score of proofs of the size of a quarter of a sheet; after toning them, it is advisable to restore the energy of the bath by adding a small quantity of the solution of chloride of gold, and a little pinch of chloride of lime. But, until the operator has gained considerable experience, it is better to prepare a new bath altogether after toning the number of proofs mentioned. The residues may be put aside, and the gold extracted by means of sulphate of iron. The permanency of a proof toned in this bath is very great, and its whites strikingly clear; the gold is deposited on the reduced silver which forms its blacks, at the same time that the coloured organic matter of the paper is restored to a white, by the well-known action of the chloride of lime.

One of the chief causes of its permanency, also, is the complete absence of free nitrate of silver in the fibres of the paper. In fact, when a sheet of paper containing free nitrate of silver is put in a hyposulphite of soda bath, this nitrate decomposes the bath by giving birth, in the substance and on the surface of the sheet, to sulphur, and to a sulphide of silver, which subsequent washings in water cannot remove from the proof, and which are an ultimate cause of change.

By submitting the proof to the action of the chloride of lime, previous to fixing, all the free nitrate is converted into chloride of silver, which, being completely soluble in hyposulphite of soda, can be entirely removed from the proof by a suitable exposure to its action; only, as the quantity of free nitrate of silver in the proof is somewhat conspicuous in reducing the chloride of lime bath to such a very weak proportion, it will be readily understood that after two or three proofs it would all be decomposed, and that, in consequence, I am obliged to add chloride to the bath, inert as regards the toning action; this is chloride of sodium, to furnish an element to the decomposition of the free nitrate of silver into chloride.

In comparing the proofs obtained by my process with those obtained by the old method, I must tell you that they were taken on paper prepared several days previously, and discoloured; in the old process this discoloration is evident, but in mine the tones are fresh, and the paper white. I would also observe that one great advantage of the new process is to enable it to be perceived directly it is dry, if the proof has been thoroughly deprived of its chloride of silver.

In cases where it remains in the fibres of the paper, this chloride will blacken immediately, and be rendered evident by transmitted light in the form of black spots.

To know, in a mathematical manner, the time it is necessary to leave the proof in the hyposulphite of soda bath for all the chloride to be removed, the following experiment must be employed:—

Put in two test tubes a like quantity of the hyposulphite of soda (500 parts of solution for example); then take one part of dried chloride of silver, and one part of iodide of silver, and these two products must be put, at the same moment, in each of the two tubes, and the exact time noted on a watch. The iodide requires a longer time to dissolve, the difference varying according to the temperature; the difference between the solubility must be noted. This known, a sheet of paper is prepared with the iodide of silver, with the same proportion of iodide by weight as the