Édouard-Léon Scott de Martinville: An Annotated Discography

The playback of phonautograms recorded by Édouard-Léon Scott de Martinville in the 1850s and 1860s has stimulated new interest in his groundbreaking work in sound recording. This discography lists and describes all Scott phonautograms currently known to exist.

Édouard-Léon Scott de Martinville (1817-1879) has long been recognized as the inventor of the phonautograph, the first instrument designed to inscribe the movements of a taut membrane under the influence of sounds passing through the air, using the same principle of recording later employed in Edison's phonograph. By contrast, Scott's legacy as an actual recordist has only recently begun to come to light. For many years, speculation about the recovery of Scott's own phonautograms centered on an unfounded rumor that he had visited the White House and captured the voice of Abraham Lincoln in 1863.[1] Now we know that Scott did in fact bequeath us an extensive body of incunabular recorded sound, preserved today in several French archives. My present aim is to list and describe every phonautogram recorded by Scott that is currently known to exist. This is by no means intended as a final word, but only as a first step: the task of interpreting this material will doubtless occupy generations to come, drawing on insights and strategies we can as yet scarcely imagine. It has become customary to refer to lists of sound recordings as "discographies" even when they focus on cylinders or other non-disc media, so I hope it won't raise too many eyebrows for me to call this a Scott *discography*.

Even though Scott recorded sounds for visual apprehension rather than for playback, the subjects he chose and the ambitions he expressed bear a striking resemblance to those we associate with later phonographic practice. Nineteenth-century acoustics textbooks – and most secondary literature until very recently – would have led us to expect no more interesting subject matter than split-second vowel snippets or studies of intervals sounded on organ pipes inscribed for dispassionate scientific study. Instead, Scott has given us singing, dramatic recitations, and scales or melodies played on the cornet. One of his ultimate objectives is revealed in a question he posed rhetorically at the start of 1857: "Pourra-t-on conserver à la génération future quelques traits de la diction d'un de ces acteurs éminents, de ces grands artistes qui meurent sans laisser après eux la plus faible trace de leur génie?" ["Will one be able to preserve for the future generation some features of the diction of one of those eminent actors, those grand artists who die without leaving behind them the faintest trace of their genius?"] (*PM* 5).[2] Scott's motives, then, were aesthetic as well as scientific, directed towards posterity as well as

towards the world of his contemporaries. His phonautograms anticipated more familiar phonographic developments not just in a technical sense, but in a cultural sense as well.

I have defined the basic unit in this discography as the *item*, meaning a single side of a physical sheet of paper, regardless of whether that side contains multiple traces or has multiple pieces of phonautograms affixed to it. Items appear in chronological order as far as the current state of knowledge permits, and individual entries are organized as follows:

- assigned item number, assigned title, estimated date
- transcription of any notations found on the item itself (in boldface)
- archival location of the physical artifact
- circumstances of deposit, construed here as meaning when an item left Scott's hands
- physical description
- any other contemporary references to the item
- comments

English translations of French texts are also provided in brackets wherever appropriate.

The quest for phonautograms reflected in this discography has now been underway for several years and has involved substantial contributions from many quarters. My first knowledge of a surviving Scott phonautogram came in 2004, when Jean-Paul Agnard kindly sent me fourth-generation photocopies of Scott's handwritten patent papers, including two that displayed the top and bottom of item 33.[3] I drew attention to this document in 2007, when David Giovannoni, Richard Martin, Meagan Hennessey and I first began brainstorming together about the world's earliest surviving sound recordings and how they might be made to "talk." These discussions led in turn to the formation of the informal collaborative of audio historians, recording engineers, sound archivists, scientists, and other interested parties known as First Sounds, which provided the context for subsequent developments. When David visited the Institut National de la Propriété Industrielle (INPI) that December to obtain a high-resolution scan of item 33 as the basis for a playback attempt, he found item 2 in the same set of documents. Some passages in Scott's 1878 book, *Le Problème de la parole s'écrivant elle-même*, led me to conclude at the beginning of 2008 that there ought to be additional Scott phonautograms in the archives of the Académie des Sciences,[4] and David's diligent pursuit of this lead brought us access in March 2008 to items 1, 35-36, and 45-50.[5] These materials were new to us at the time, but I should mention that George Brock-Nannestad had also examined the INPI and Académie documents in connection with the phonautograph sesquicentennial in 2007.[6] The playback of item 36 by the First Sounds initiative gained international media attention and brought new momentum to our search for primeval sound traces.[7] That same month, I happened across an online catalog entry listing further Scott phonautograms among the Victor Regnault papers in the library of the Institut de France – items 34 and 37-44.[8] A First Sounds delegation consisting of David, Laurent Scott de Martinville, and Karen Akerson first confirmed their existence in November 2008, and the information about them found in this discography was drawn primarily from photographs Michael Devecka and David took together that December.[9] We also knew that Scott had submitted some materials to the Société d'Encouragement pour l'Industrie Na-

tionale (SEIN),[10] but an article I had read suggested that the relevant parts of the SEIN archives had been lost years ago to water damage.[11] Fortunately, David brought the matter up in a conversation with Valérie Marchal at INPI, who in turn consulted Gérard Emptoz of the SEIN historical commission.[12] This led to the unearthing in December 2008 of yet another cache of Scott phonautograms – items 3-32 – which David enabled Melissa van Drie and myself to scan on behalf of First Sounds in April 2009. The present discography would not have been possible without these ongoing collaborative efforts to locate and make public Scott's surviving legacy of recorded sound. Of course, the responsibility for any errors of fact or interpretation rests with me.

In order to assess the physical characteristics of phonautograms correctly, it will be necessary for us to understand something of how they came into being. The first three items listed in the discography used a "flat plate" format, but all remaining items were recorded as helical traces on sheets of paper wrapped around cylinders. Scott would first attach one edge of a sheet of paper to the cylinder, stretch the paper all the way around, and then attach it to itself, creating a loop and covering up a wider or narrower strip at the point of overlap. He would then blacken the paper with the smoke of an oil lamp, leaving the covered strip unblackened – I'll call this underlap area the *margin*. The paper nearest the edges of the cylinder often ended up less thoroughly blackened than the rest, resulting in inferior contrast in these areas.

Then it was time to record. In 1857, Scott typically used only a single recording stylus – the one attached to the membrane at the end of his conduit or funnel – though sometimes this had a frayed or brushlike tip that drew up to four parallel lines at once. In a *single-trace* phonautogram, the stylus made only one helical pass around the cylinder, analogous to recording a single mono track on a tape. In a *multiple-trace* phonautogram, one or more additional traces were recorded in the interlinear space left between the turns of the first trace, analogous to recording multiple mono tracks on a tape at different times. By 1860, these approaches had been superseded by the *trace-plus-timecode* phonautogram, in which the space between the turns of the "main" trace was dedicated to a second trace made simultaneously by a stylus attached to a tuning fork. This was arguably analogous to recording two stereo tracks on a tape, although it was of course not intended to yield a "stereo effect."

When Scott removed a sheet from the cylinder after recording and flattened it out, it became a rectangle with linear traces running across its width at a slight angle. Traces that had originally been made continuously around the cylinder – and across the join in the paper – were now broken into strips, with each successive strip corresponding to one successive turn of the feedscrew. I will refer to a recorded strip of this kind as a *rotation*; note that a single rotation of a multiple-trace or trace-plus-timecode phonautogram generally contains sections of more than one trace.

Next, Scott sometimes scratched some notes into the lampblack, typically at the bottom but occasionally along the trace itself or at the beginning or end. When he did so, he usually oriented himself towards the paper by analogy with the familiar conventions of alphabetic writing: the beginning of the trace was at the top, the end was at the bottom, and the trace itself ran from left to right.[13] This left the margin on the right, presumably reflecting consistency in the direction of wrapping.[14] Then Scott fixed the lampblack by immersion in baths of alcohol. All the steps described so far would have taken place in rapid succession at the time of recording.

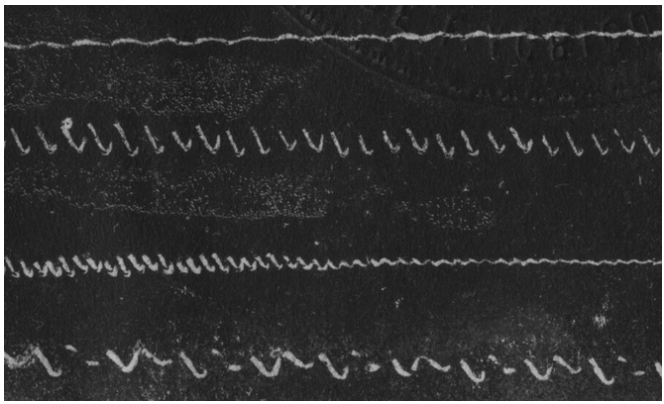

Figure 1. *Detail of a "flat plate" phonautogram recorded in early 1857. Each trace represents a discrete pass across the plate rather than part of a continuous helical rotation around a cylinder (item 2, FirstSounds.org).*

We encounter a lot of consistency in the dimensions of Scott's phonautograms, as we would expect from his repeated use of the same apparatus. They typically have a height (corresponding to cylinder length) of about 22.5 cm and a trace pitch of about 1.12 cm, allowing for twenty rotations, although Scott rarely used more than seventeen. Phonautograms made in the latter half of 1857 and 1859 have a consistent width (corresponding to circumference) of roughly 52.5 or 53 cm, but those made in 1860 reduce this dimension to 50 or 50.5 cm, presumably reflecting a switch to a different recording cylinder. Minor variations are common due to stretching, shrinkage, and irregular trimming of the paper, but the discography notes any more substantial departures from the usual range of dimensions.

Many phonautograms listed in the discography have undergone further labeling or modification. Sometimes Scott cut small pieces out of phonautograms and mounted them on sheets of paper with captions explaining what they were. I identify these in the discography as *fragments* whenever their width is less than the majority of the circumference of the cylinder (items 34 and 35). Sometimes Scott also mounted whole phonautograms on sheets of backing paper, except that he cropped off the unblackened margin and occasionally made further cuts at top, bottom, or edge. Inscriptions in ink or pencil went in the margin of an unmounted phonautogram or in the space underneath or to the right-hand side of a mounted one. Every now and then Scott also wrote in ink on the blackened portion of a phonautogram, correcting or touching up notations he had made at the time of recording. Unlike notes scratched in the lampblack itself, which had to be made before a phonautogram was fixed in alcohol, notes in pencil and ink could be made at any future time. A date written in pen or pencil can refer not to the time of recording, but to the time of labeling; thus, item 9 has the date October 1857 written in ink in its margin but the date 17 August 1857 scratched definitively in the lampblack itself. Scott often assembled phonautograms into numbered series for purposes of presentation, but the numbering reflects only his organizational logic at the time of assembly and implies nothing definite about the order of recording.

The Scott dossier at the SEIN poses some special interpretive challenges that are worthy of mention here. Some of the phonautograms in it match cover letters documenting their official submission, but others (often found filed together in apparent groups) do not. Scott had probably given these "extra" items personally and informally to Jules Lissajous, whom the SEIN had assigned to investigate and pass judgment on his work. At some point, an archivist rubber-stamped each document "S. E. I. N. ARCHIVES" and assigned it a sequential number based in its position in the folder at the time, ranging from 8/54-1 (a cover document) through 8/54-37. This sequence clearly doesn't reflect the order in which Scott created or deposited the documents – his own numbered series are jumbled and scattered throughout the folder – but it may reflect the order in which Lissajous left them after completing his report at the start of 1858. In particular, 8/54-25 (item 28) documents an experiment in which Lissajous was personally invested, and 8/54-26 through 8/54-28 (items 9, 13, and 14) all contain signed notations by Lissajous acknowledging that they "proved" the phonautograph could be used to study frequency or timbre. I hypothesize that items numbered from 8/54-25 upward may comprise a special subset of materials Lissajous kept out for ongoing reference after having determined that nothing up through 8/54-24 warranted further scrutiny. If so, the current order of documents in the dossier may reveal which phonautograms Lissajous considered more or less interesting.[15]

Items 49 and 50 have sometimes been identified as photographic reproductions,[16] but on closer examination it can be seen that physical irregularities along the left edges of these documents correspond to irregularities in the boundaries of the right-hand margins (Scott trimmed the margins prior to mounting but left a tiny unblackened strip in both cases). This correspondence shows that the ragged left edges of these specific sheets of paper were physically present at the time of blackening, and hence that the phonautograms on them must be originals. I find no evidence that Scott ever used photographic processes to duplicate any of his helically recorded phonautograms. On the other hand, item 1 definitely consists of two small photographic paper prints of phonautograms made on flat glass plates. Scott's own terminology is somewhat confusing in this regard: in his writing, he uses the term *épreuve* (ordinarily "print" or "proof") to refer both to original phonautograms and to photographic duplicates. I have left this word untranslated here to draw attention to its ambiguity.

I have excluded most information about playback efforts from the discography, since any specifics I could give would soon be out of date. However, all items listed in this discography are playable to some degree. The results may not always be audibly identifiable with the "original" sounds, but sounds can still be generated according to consistent strategies that are equivalent in the case of undistorted waveforms to "playing" the groove of a gramophone disc – a process I refer to as *eduction*. Thus far, two methods have been applied successfully to the eduction of Scott phonautograms. The first – carried out by Carl Haber, Earl Cornell, and David Giovannoni – centers on the use of a "virtual stylus," based on the IRENE system.[17] The second, which I have been implementing, entails converting the traces into bands of varying width compatible with digital playback systems for optical film sound tracks.[18] Quite apart from the choice of method, there are also philosophical dilemmas involved in eduction – dilemmas similar to those associated with the transfer and restoration of historic phonograms in general, but exacerbated in Scott's case by loopback, broken traces, marks made by parts of the

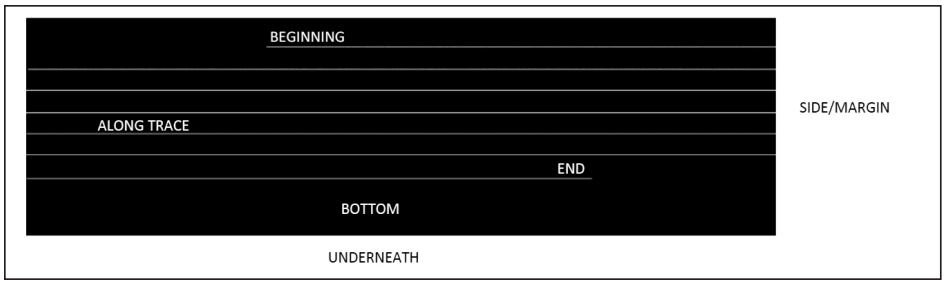

Figure 2. *Simplified diagram of the layout of a helically recorded phonautogram, with names shown for the places in which Scott made written notations. In the discography,* margin *refers to an unblackened part of the original phonautographic sheet, while* side *refers to part of a backing paper on which a phonautogram is mounted.*

stylus other than the tip, and other catastrophic departures from the orthogonal graphing of amplitude versus time. Should the goal be (1) to create the digital waveform most closely equivalent to the shape of the phonautographic trace, (2) to infer from that shape the motions of the phonautographic membrane that produced it, or (3) to infer from those motions in turn the aerial sounds that produced them? Each successive inference in this chain compounds the risk of error. However, each of the three goals has its own merits, and it is to be hoped that all three will be pursued with due rigor.

One type of restoration is clearly defensible, regardless of which method or philosophy of eduction one chooses: the time correction of trace-plus-timecode phonautograms. Scott himself stated that "la main tourne la manivelle du cylindre et le papier avance avec une vitesse à peu près uniforme que la main acquiert vite par la pratique" ["the hand turns the crank of the cylinder and the paper advances at a nearly uniform speed which the hand acquires quickly through practice"],[19] but in actuality the speed fluctuated so greatly that it is generally impossible to discern a sung melody by ear from an uncorrected sound file. Whenever Scott recorded a tuning fork timecode alongside the "main" trace, we can factor out those fluctuations – say, by adjusting every five tuning fork cycles to a set duration – but to restore the original recording speed we also need to know the frequency of the tuning fork. Scott wrote that he used a tuning fork of "500 simple vibrations per second." According to his own explanatory notes (*PM* 76-78), a "simple vibration" is a quarter cycle, in which case "500 simple vibrations per second" should mean 125 Hz. As soon as my First Sounds colleagues and I heard the opening rotations of item 36, however, we concluded by ear that this was far too slow, and that Scott must have been mistaken or confused. Adjusting the timecode to 500 Hz gave us what we took to be the natural-sounding voice of a young girl singing at a convincing speed, and that was the version First Sounds originally unveiled. The same speed remained plausible for item 46, a phonautogram of a vocal scale educed and released to the public later in 2008. However, early 2009 brought us the eduction of a third trace-plus-timecode phonautogram: item 45, documenting speech rather than singing. This time, adjusting the timecode to 500 Hz as before yielded an eduction that sounded very much like a tape played back at twice the proper speed. On the other hand, adjusting the timecode to 250 Hz gave us a natural-sounding low male voice for items 45 and

46 and a plausible (though lugubrious) item 36.[20] This made a great deal of sense in retrospect: despite Scott's own statements to the contrary, "500 simple vibrations per second" would clearly have meant 250 Hz in the terminology of mid-nineteenth century acoustics.[21] Since then, the eduction of additional phonautograms has confirmed 250 Hz beyond reasonable doubt as Scott's timecode frequency.

Phonautograms without timecode cannot be speed-corrected with the same degree of confidence or objectivity as those with timecode can. That said, it may still be possible in some cases to restore such phonautograms to something resembling a "correct" speed. For example, early investigation suggests that item 29 documents several eight-note sequences played on a cornet à piston between each of which Scott stopped the rotation of the cylinder. A repeated eight-note sequence is likely to be an ascending scale, and "correcting" the notes on that assumption does yield a plausible-sounding result. That in itself doesn't prove anything, of course, but if other evidence were to point towards the same conclusion – for example, periodic patterns in pitch fluctuation identifiable with cranking – we might eventually assemble enough circumstantial evidence to make a persuasive case.[22] Even so, a restoration of item 29 as a set of ascending cornet scales would require us to impose outside knowledge of nineteenth-century cornet tunings – and yet Scott might have recorded an out-of-tune or atypically tuned cornet.

Fifty items are listed here, comprising four "flat plate" phonautograms, eight fragments, and forty-five helically recorded sheets of which sixteen contain multiple, non-simultaneously recorded tracks. At the end of 1859, however, Scott claimed already to have dedicated "more than fifteen hundred experiments" to his work in phonautography.[23] Thus, the phonautograms we currently know about would still seem to represent only a small fraction of his total recorded oeuvre, and other specimens may well survive. Still, as of this writing it has been nearly a year since the last "new" Scott phonautogram turned up, and it seems a good idea to take advantage of the lull in action to codify what is presently known.

1. PREMIERS ESSAIS DE FIXATION DU SON late 1853 or early 1854

Underneath plate on left, in ink: **(parole)** [(speech)]

Underneath plate on right, in ink: **(guitare)** [(guitar)]; **Premiers essais de fixation du son remontant à trois années exécutés sans aucun instrument.** [First attempts at fixing sound dating back three years carried out without any instrument.]

Location: Archives of the Académie des Sciences, attached to page 7 of "Principes de Phonautographie," manuscript dated 25 January 1857 (*PM* 4-12).

Deposit: submitted in a sealed packet (No. 1639) on 26 January 1857.

Physical Description: Paper prints mounted to one page of a manuscript; "speech" ca. 8 cm × 8.5 cm; "guitar" ca. 9 cm × 7 cm. The left half of the "guitar" plate contains several irregular circular or spiral traces, while the right half contains more or less parallel linear traces, mostly from the center of the plate to the right edge. The "speech" plate consists of linear traces across its entire width.

References: Elsewhere on the page to which these prints are attached, Scott writes: "Voici comme preuve de mes assertions quelques épreuves de mes premiers essais, obtenues avec deux morceaux de verre et des membranes de papier. Les figures sont ~~donc~~ encore inégales, la table de verre étant conduite à la main. ["Here as proof of my assertions are some *épreuves* of my first attempts, obtained with two pieces of glass and from

membranes of paper. The figures are ~~thus~~ still uneven, the glass table being driven by hand"] (*PM* 12). In the manuscript of a talk given on 28 October 1857, Scott states further: "Il y a quatre ans, j'ai fait une première expérience chez ~~M. Giacomelli rédacteur du Luth français~~ un musicien, avec l'assistance de ~~MM. Sabbatier, Reboux père et fils~~ plusieurs amis; j'ai déposé un paquet cacheté descriptif à l'Institut au mois de janvier dernier. Ce paquet contient des épreuves faites il y a quatre ans" ["Four years ago, I made a first experiment at the house of ~~Mr. Giacomelli editor of the *Luth français*~~ a musician, with the assistance of ~~Messrs. Sabbatier, Reboux father and son~~ several friends; I deposited a sealed descriptive packet at the Institut in the month of January last. This packet contains *épreuves* made four years ago"] (*PM* 39).

Comments: These appear to be prints of Scott's very first phonautograms. The combination of circular and linear traces in the "guitar" plate may reflect Scott's initial uncertainty as to the most practical way of moving the plate by hand, while the "speech" plate may have been made after he had settled on trying to move the plate in a straight line rather than rotating it. Scott stated that these phonautograms were *three* years old in January 1857 but *four* years old in October 1857, which points to a recording date in late 1853 or very early 1854. In the "Principes de Phonautographie," he adds: "Sous peu de jours j'aurai l'honneur de vous présenter des épreuves plus significatives" ["Within a few days I shall have the honor of presenting you with more significant *épreuves*"] (*PM* 12), which hints that he had not recorded anything more impressive than these two plates as of 26 January 1857 but was planning to do so in the near future. This interpretation would be consistent with his characterization of his phonautographic research in the same document as "longtemps interrompues" ["long interrupted"] (*PM* 4). The "M. Giacomelli" at whose house the experiments are said to have been made was Adolphe Giacomelli, also prominent as a theatrical agent.

2. PHONAUTOGRAPHIE DE LA VOIX HUMAINE À DISTANCE early 1857

Underneath, in ink: **phonautographie de la voix humaine à distance.** [phonautography of the human voice at a distance.]

Underneath, upside down, in pencil: **31470/4**; *top right, in pencil:* **5**

Location: INPI, plate included with Scott's *brevet d'invention*, number 31,470, page number 5.

Deposit: with *brevet d'invention*, 24 March 1857.

Physical Description: Paper, mounted on a paper backing, ca. 30.3 cm × 12.3 cm, 18 separate parallel traces, apparently recorded starting from a state of rest at the right edge; some small holes are torn in the sheet as though it had once been glued to a flat surface and imperfectly removed.

References: In the accompanying manuscript, Scott writes: "Pour plus de clarté j'annexe au dessin de mes appareils une épreuve en double des figures acoustiques de la voix, du cornet à piston, des dessins que j'obtiens avant toute construction d'appareils et par l'usage unique du procédé de la figure 1" ["For greater clarity, I am appending to the drawing of my apparatuses an *épreuve* in duplicate of the acoustic figures of the voice, of the cornet – of drawings I obtain before any construction of apparatuses and by the sole use of the process of figure 1"] (*PM* 18).

Comments: Scott's references in the patent text to voice *and* cornet as subject matter and the submission "en double" ["in duplicate"] are not an obvious match for the accompany-

ing phonautogram, as labeled. However, it is likely that each trace of item 2 documents a single note, much as item 3 documents individual notes on the cornet, so "en double" might conceivably refer to pairs of traces documenting the same note for comparison (either both sung, or one vocal versus one played on the cornet as a point of reference). Scott's allusion to the voice being recorded "at a distance" stresses his fundamental innovation of using a membrane to register aerial sound waves. Figure 1 in the *brevet d'invention* depicts a stylus attached to a single membrane at the end of a conduit that is not fully shown (*PM* 15). In stressing the "sole use" of the process shown in this figure, Scott presumably meant to clarify that he had not used the full apparatus described in his patent, which would have included two membranes and various adjustable parts. Item 2 could perhaps be the phonautogram "représentant les vibrations produites par la voix humaine" ["representing the vibrations produced by the human voice"] referenced by the Viscount du Moncel in the first known reference to phonautography in print.[24]

3. CORNET: GAMME PAR DEMI-TONES early 1857

Top left, in lampblack: two apparent bottom halves of letters partially cropped, perhaps "GR"

Side, in ink: **ut | ut# | ré | ré# | mi | fa | fa# | sol | sol# | la | la# | si | do² | do#² | ré² ton fondament. du tuyau** [fundamental tone of pipe]

Immediately underneath, in ink: **cornet. | L. Scott, brevet d'invention s.g.d. gouv. | mars 1857** [cornet. | L. Scott, patent without governmental guarantee | March 1857]

Further underneath, in pencil: **cornet | gamme par demi-tones – Le nombre des vibrations est parfaitement conforme aux principes théoriques – mais l'appareil n'est pas réglé à la seconde** [cornet | scale by half-tones – The number of the vibrations is perfectly in keeping with theoretical principles – but the apparatus is not regulated to the second]

Location: SEIN 8/54-2.

Deposit: unknown; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, ca. 30.2 cm × 11.5 cm; fifteen separate parallel traces, apparently recorded starting from a state of rest at the left edge, individually labeled with notes of the scale, made with a stylus ending in a composite, brushlike tip.

Comments: The enigmatic reference in the 1857 patent text to the cornet as subject matter (see comments on item 2) suggests that Scott had a particular interest in recording the sound of this instrument during the "flat plate" period. In the patent text, Scott also states: "Je me propose d'appliquer mon procédé à la construction...d'un accordeur mathématique de tous les instruments" ["I propose to apply my process to the construction...of a mathematical tuner for all instruments"] (*PM* 14), and in the "Principes de Phonautographie" he claims: "Convenablement construit, cet appareil me paraît propre à fournir dès aujourd'hui un accordeur universel" ["Properly built, this apparatus seems to me suitable to furnish as of today a *universal tuner*"] (*PM* 11). That is presumably the use scenario Scott was seeking to illustrate with item 3, the idea being that someone would use a phonautograph to find out whether a given cornet was in tune or not. Of course, as long as the linear motion of the recording medium was irregular – "not regulated to the second" – the traces could not actually be used to measure frequency, making

this plate a mere mock-up rather than a real study. Scott's *brevet d'invention* further describes a "style, simple ou composé à son extrémité" ["stylus, simple or composite at its end"] (*PM* 16); this is also seen in item 4.

4. CHANT DE LA VOIX – CHANGEMENTS DE TON July 1857

Underneath, in ink: **~~Axxxx~~ le Chant de la voix – changements de ton – membrane de baudruche perpendiculaire – vitesse à la main | Juillet 1857** [~~Xxxxx xx~~ Song of the voice – changes of tone – perpendicular membrane of goldbeater's skin – speed by hand | July 1857]

Location: SEIN 8/54-3

Deposit: unknown; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, but the right edge of the phonautogram extends well beyond the right edge of the backing paper; helical multiple-trace; twenty rotations; recorded with a stylus ending in a composite, brushlike tip.

Comments: This is Scott's earliest known helically recorded phonautogram, and hence the oldest one we possess with a duration greater than a split second – the first opportunity Scott would have had to document "changes of tone," or continuous sung melodies or scales. It is unclear from the inscription when during July this phonautogram was recorded (or mounted and labeled), but Scott reported on some recently conducted experiments in a document entitled "Graphie du son," dated 22 July and deposited with the Académie des Sciences on 27 July (*PM* 19-20), so he appears to have been actively engaged in phonautograph work towards the end of the month. The note "speed by hand" refers to the fact that Scott turned the cylinder manually during recording – something he would continue to do in all future cases, as far as is known. Scott did not write selection titles on any of the known "song" phonautograms he recorded during 1857, with the possible exception of item 9, so it is unclear what song or songs he was using as test pieces in this period, and *chant* could even mean merely "singing," for instance of a vocal scale. The perpendicular placement of the membrane relative to the axis of the conduit contrasts with the oblique placement noted in item 13. On the composite stylus tip, see item 3.

5. VOIX HUMAINE – CHANT August 1857

Underneath, in ink: **voix humaine – chant | Léon Scott – août 1857** [human voice – song | Léon Scott – August 1857]

Location: SEIN 8/54-30

Deposit: unknown; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, helical multiple-trace, twenty rotations, with a vertical strip approximately 4 cm wide missing from the right or left edge.

Comments: It is unclear from the inscription when during August this phonautogram was recorded (or mounted and labeled). However, the fact that it contains a full twenty rotations, like item 4, rather than a lesser number of rotations as all other known helical phonautograms do, suggests it may fall chronologically between item 4 and the items that follow. I speculate that Scott stopped trying to fill his sheets to capacity sometime in early August to avoid having the stylus run off the "bottom" in mid-recording, as

happened in both items 4 and 5. He might have dedicated the missing vertical strip to some other purpose, or he may simply have wanted to crop off a section that had been torn or otherwise damaged in removal from the cylinder.

6. LA VOIX CHANTÉE ca. Aug.-Oct. 1857

Underneath, in pencil: **la voix chantée écrite par elle-même à 50 centimètres de distance** [the sung voice written by itself at 50 centimeters of distance]

Location: SEIN 8/54-15

Deposit: unknown, but items 6-8 (SEIN 8/54-15 through 17) may have formed a group; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, helical multiple-trace, height ca. 19.4 cm.

Comments: The notation that the voice was recorded at a distance of 50 cm suggests that this detail was still considered novel at the time (cf. item 7). Like items 4 and 5, this phonautogram is labeled merely as documenting vocal singing – a very general description of its subject matter, probably reflecting a stage at which such basic experiments were still new.

7. NOTES CADENCÉES ca. Aug.-Oct. 1857

Bottom, in lampblack: **notes cadencées – on voit l'onde de condensation et l'onde d'inflexion se produire simultanément** [cadenced notes – one sees the wave of condensation and the wave of inflection produced simultaneously]

Underneath, in pencil: **la cadence dans le chant à 50 centimètres de distance** [the cadence in the song at 50 centimeters of distance]

Location: SEIN 8/54-16

Deposit: unknown, but items 6-8 (SEIN 8/54-15 through 17) may have formed a group; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, helical single-trace, height ca. 20 cm. A trace of "le toton d'acier" ["the steel teetotum"] is attached to the same backing sheet, on the left.

Comments: The experiment described here closely resembles the one documented in item 16. The notation that the voice was recorded at a distance of 50 cm suggests that this detail was still considered novel at the time (cf. item 6). Physiologists associated "waves of condensation" with vibrations conveyed to the eardrum directly by the air and "waves of inflection" with those conveyed to it by passing along the walls of the auditory conduit.[25] Scott seems to have identified "waves of inflection" visually with longer-period, higher-amplitude oscillations superimposed on the ordinary "waves of condensation," as illustrated in Fig. 3 and described further in the notes attached to item 16.[26] Scott's 1857 patent text associates an oblique placement of the membrane relative to the axis of the conduit with the ability to record such "waves of inflection" (*PM* 15), and the notes on item 13 explicitly state that the membrane was positioned in that way, which may have been a consistent arrangement for all of Scott's "waves of inflection" phonautograms. The phrase *notes cadencées* ["cadenced notes"] conventionally refers to "trilled" notes, which may be the sense in which Scott means "cadences" here and in item 16.

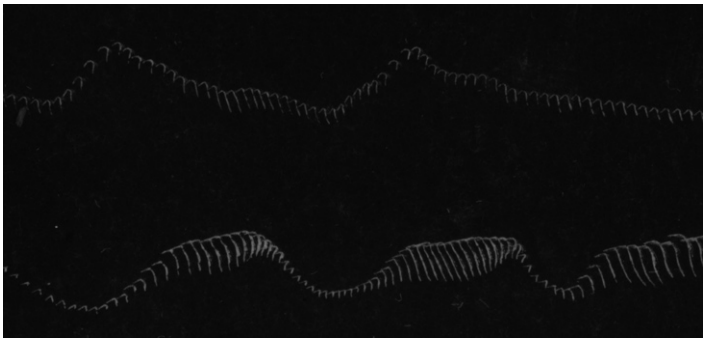

Figure 3. *Based on traces such as these, Scott asserted in 1857 that longer-period, higher-amplitude "waves of inflection" were superimposed on shorter-period, lower-amplitude "waves of condensation" (item 16, FirstSounds.org).*

8. TUYAU DE FRÊNE (a) ca. Aug.-Oct. 1857

Bottom, in lampblack: **vibrations du bois sous l'influence de la voix** [vibrations of wood under the influence of the voice]

Underneath, in pencil: **graphie moléculaire d'un tuyau de frêne sous l'influence de la voix** [molecular writing of a pipe of ash under the influence of the voice]

Location: SEIN 8/54-17

Deposit: unknown, but items 6-8 (SEIN 8/54-15 through 17) may have formed a group; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing, helical multiple-trace, height ca. 18.5 cm.

Comments: See item 10.

9. JEUNE JOUVENCELLE 17 August 1857

Beginning, in lampblack: **jeune jouvencelle** [young little girl]

End, in lampblack: **les** [or **des**] **echos** [the echoes, *or* of the echoes]

Bottom, in lampblack: **17 août 1857 – L. Scott | chant à distance** [17 August 1857 – L. Scott | song at a distance]

Margin, in ink: **octobre 1857 | S[co]tt** [October 1857 | Scott]; **pl. 2.** [pl. 2.]; **Cette planche prouve que l'appareil est apte à compter les vibrations | J. Lissajous [**This plate proves that the apparatus is capable of counting vibrations | J. Lissajous]

Location: SEIN 8/54-27

Deposit: with SEIN 8/54-12, a cover letter apparently submitted before 28 October 1857, covering items 9-12.

Physical Description: Paper, unmounted, helical single-trace.

References: In the cover letter, Scott writes: "Les planches 2, 3, 4 montrent le mouvement d'une membrane sous l'influence de la voix et particulièrement l'onde d'inflexion ou ~~transversale~~ longitudinale de la membrane, particularité sur laquelle la science ne possède encore aucune

lumière" ["Plates 2, 3, 4 show the motion of a membrane under the influence of the voice and particularly the wave of inflection or the ~~transverse~~ one longitudinal to the membrane, a characteristic on which science does not yet possess any light"]. He states further: "Je compte mettre sous peu sous vos yeux le mouvement du pendule à fil et le tracé de la parole" ["I intend soon to place beneath your eyes the motion of the string pendulum and the trace of speech"] (*PM* 21).

Comments: This phonautogram contains the earliest known example of a date scratched in the lampblack – and hence definitely inscribed at the time of recording – rather than written in ink. It is also the earliest case of a phonautogram associated with a specific day rather than a month, and only one of two such cases known from 1857, the other being item 24. The significance of the beginning and end inscriptions is unclear; they could conceivably refer to song titles, lyrics, or subject matter. As in item 7, Scott emphasizes the presence here of "waves of inflection," while the notation by Lissajous shows that he saw this phonautogram as a good example of the documentation of frequency.

10. TUYAU DE FRÊNE (b) ca. Aug.-Oct. 1857

Margin, in ink: **planche 1.** [plate 1.]; **octobre 1857** [October 1857]

Location: SEIN 8/54-7

Deposit: with SEIN 8/54-12, a cover letter apparently submitted before 28 October 1857, covering items 9-12.

Physical Description: Paper, unmounted, helical multiple-trace.

References: In the cover letter, Scott writes: "Je vous dirai que le bois et d'autres corps écrivent comme les membranes leurs vibrations sous l'influence de la voix. La planche 1 a été écrite par un tuyau de frêne d'un centimètre d'epaisseur" ["I will say to you that wood and other bodies, like membranes, write their vibrations under the influence of the voice. Plate 1 was written by an ashen pipe one centimeter in thickness"]. He also characterizes the content of the deposit as a whole as "un spécimen des expériences que je poursuis sur la graphie des mouvements rapides, des mouvements moléculaires, du son des instruments et des voix" ["a specimen of the experiments which I am pursuing on the writing of rapid motions, of molecular motions, of the sound of instruments and of voices"] (*PM* 21).

Comments: This is one of three phonautograms Scott recorded by attaching his stylus to an ashen pipe rather than to a membrane; the others are items 8 and 15. Judging from item 9, an October date written in ink on phonautograms accompanying cover letter 8/54-12 refers strictly to when they were labeled for deposit, and not to when they were recorded. The other phonautograms submitted with 8/54-12 (items 9, 11, and 12) are all characterized as documenting the human voice, and two teetotum traces physically attached to 8/54-12 document "rapid motions" but not sound. By process of elimination, it seems the documentation of "the sound of instruments" mentioned in the cover letter would have to appear in item 10 if at all. Apart from earlier phonautograms of the guitar (item 1) and the cornet (item 3), Scott mentions having recorded the oboe in his presentation of 28 October (*PM* 35).[27] On the other hand, Scott also states in his cover letter that a wooden body could be used to record the voice, arguably implying that "plate 1" furnishes evidence of that claim. This leaves the content of item 10 something of a mystery; perhaps it combines a variety of subject matter.

11. STYLE DE SOIE (a) ca. Aug.-Oct. 1857

Margin, in pencil: **style de soie** [stylus of bristle]

Margin, in ink: **pl. 3.** [pl. 3.]

Location: SEIN 8/54-36

Deposit: with SEIN 8/54-12, a cover letter apparently submitted before 28 October 1857, covering items 9-12.

Physical Description: Paper, unmounted, helical multiple-trace.

References: See item 9.

Comments: Scott's cover letter (*PM* 21) establishes that items 9, 11, and 12 are all phonautograms of the voice made with a membrane, and since the same letter also promises "the trace of speech" as a future deposit, all of these items presumably document singing rather than speech. The notations on items 11 and 12 indicate that Scott considered both to be distinctive for their use of a "stylus of bristle." It is not clear whether this detail was noted in contrast to other phonautograms of the same period, or whether the bristle stylus was simply a recent innovation at the time and therefore still noteworthy. Scott had already mentioned the use of a "soie de sanglier" ["boar's bristle"] as a stylus in the "Principes de Phonautographie" (*PM* 9).

12. STYLE DE SOIE (b) ca. Aug.-Oct. 1857

Margin, in pencil: **style de soie** [stylus of bristle]

Margin, in ink: **pl. 4.** [pl. 4.]

Location: SEIN 8/54-8

Deposit: with SEIN 8/54-12, a cover letter apparently submitted before 28 October 1857, covering items 9-12.

Physical Description: Paper, unmounted, helical multiple-trace.

References: See item 9.

Comments: See item 11.

13. NOTES DU MÉDIUM TENUES ET VOCALISANT ca. October 1857

Margin, in ink: **Pl. I. notes du médium tenues et vocalisant – La membrane est une mince baudruche. Elle est placée, comme dans le conduit acoustique, dans une position inclinée par rapport à l'axe du tuyau. Les silences se traduisent par une ligne droite, certains renflements du son par l'onde dite d'<u>inflexion</u>. Dans les sons voilés l'onde de condensation est subdivisée en deux dents, l'une grande, l'autre petite** [Pl. I. notes of medium pitch held and vocalized – The membrane is a thin goldbeater's skin. It is placed, as in the acoustic conduit, in a position inclined with respect to the axis of the pipe. The silences are rendered by a straight line, certain swells of the voice by the wave called of *inflection*. In the muted sounds the wave of condensation is subdivided into two teeth, one large, the other small]

On reverse of sheet, in ink: **Cette planche preuve nettement que l'appareil peut servir à compter le nombre des vibrations. | J. Lissajous** [This plate proves nicely that the apparatus can serve to count the number of vibrations. | J. Lissajous]

Location: SEIN 8/54-28

Deposit: unknown, but apparently part of a group of phonautograms used to illustrate Scott's presentation of 28 October 1857 (*PM* 23-39), spanning items 13-20; henceforth the "28 October series."

Physical Description: Paper, unmounted, helical single-trace; a dotted line has been drawn from the end of the margin inscription to rotation eleven.

References: Scott states in his 28 October presentation: "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 et quelquefois deux et même trois vibrations secondaires ~~se~~ combinées avec l'onde de condensation principale" ["Here is another aspect of the question of timbre: this is a plate that shows the bad sounds of the voice, the muted sounds. With a little attention you will see one and sometimes two and even three secondary vibrations ~~xx~~ combined with the principal wave of condensation"] (*PM* 35).

Comments: The "vocalizing" of notes presumably refers here to the *vocalise,* a wordless singing exercise (see also items 18 and 26). Scott notes that his goldbeater's-skin membrane was positioned obliquely with respect to the axis of the conduit; see item 7 for the connection Scott drew between this arrangement and his ability to record "waves of inflection," which he also observes here. The notation by Lissajous shows that he considered this phonautogram a good example of the documentation of frequency.

14. UN SON DE VOIX GRAVE ca. October 1857

Underneath, in ink: **Pl. 2. Un son de voix grave tenu dans le voisinage de la membrane. Deux vibrations secondaires se produisent pendant la vibration principale** [Pl. 2. A sound of deep voice held in proximity to the membrane. Two secondary vibrations are produced during the principal vibration]

Underneath, in pencil, partly overwritten by the above: **étude du tracé des ondes par un son de voix grave** [study of the trace of the waves by a sound of deep voice]

Top, in pen: **Cette épreuve prouve nettement que l'appareil est apte à étudier le timbre. | J. Lissajous** [This *épreuve* proves nicely that the apparatus is suitable for studying timbre. | J. Lissajous]

Location: SEIN 8/54-26

Deposit: 28 October series (see item 13)

Physical Description: Paper, mounted on paper backing, helical multiple-trace (although one trace consists of little more than "dots"); only eight rotations; height ranges from about 6.9 cm to about 8.8 cm. The lampblack lightens at the top of the sheet, indicating that this was the original edge of the cylinder and that the bottom of the sheet has probably been cut away.

Comments: The inscription suggests that the vocal sounds represented in this phonautogram were produced nearer the membrane than usual. The notation by Lissajous shows that he considered this phonautogram a good example of the documentation of timbre.

15. TUYAU DE FRÊNE (c) ca. October 1857

Margin, in ink: **Pl. 3. Le style est appliqué directement sur le tuyau de frêne qui porte la membrane et trace ses vibrations sous l'influence du chant. La figure de l'onde diffère notablement des formes données par les membranes minces.** [Pl. 3. The stylus is attached directly to the pipe of ash wood which carries the membrane and traces its vibrations under the influence of song. The figure of the wave differs notably from the forms given by thin membranes.]

Location: SEIN 8/54-4

Deposit: 28 October series (see item 13)

Physical Description: Paper, unmounted, helical multiple-trace.

References: Scott states in his 28 October presentation: "Voici une planche qui fournit une notion de visu sur le mouvement ~~moléculaire~~ d'un tuyau de frêne sous l'influence de sons de la voix. Le style qui écrit a été placé directement sur le bois du tuyau au lieu de l'être sur la membrane" ["Here is a plate which furnishes an idea by sight of the ~~molecular~~ motion of an ashen pipe under the influence of sounds of the voice. The stylus which writes was placed directly upon the wood of the pipe instead of being upon the membrane"] (*PM* 34).

Comments: See item 10.

16. CADENCES ca. October 1857

Bottom, in lampblack: **cadences – on voit simultanément l'onde de condensation et l'onde d'inflexion** [cadences – one sees simultaneously the wave of condensation and the wave of inflection]

Margin, in ink: **Pl. IV. – Sous l'influence des mouvements énergiques de la glotte qui ont lieu dans la cadence, la membrane éprouve un mouvement d'inflexion longitudinale qui ne trouble pas la régularité de l'onde de condensation. Dans cette expérience le conduit a la forme du conduit auditif externe, la membrane est inclinée et tendue par le manche du marteau.** [Pl. IV. – Under the influence of energetic motions of the glottis which give place to the cadence, the membrane experiences a motion of longitudinal inflection which does not mar the regularity of the wave of condensation. In this experiment the conduit has the form of the external auditory canal, the membrane is inclined and stretched by the handle of the hammer.]

Location: SEIN 8/54-14

Deposit: 28 October series (see item 13)

Physical Description: Paper, unmounted, helical single-trace.

References: Scott states in his 28 October presentation: "Cette autre épreuve représente l'onde d'inflexion pendant une gamme cadencée de la voix.... Vous remarquerez dans mes épreuves que l'existence de ce second mouvement, de cette crête longitudinale qui parcourt la membrane d'une de ses extremités à l'autre, n'altère en rien l'onde de condensation, la vibration proprement dite; elles coexistent et cette dernière ne cesse pas de marquer la tonalité, le timbre et, dans les cas ordinaires, l'intensité" ["This other *épreuve* represents the wave of inflection during a cadenced scale of the voice.... You will notice in my *épreuves* that the existence of this second motion, of that longitudinal ridge which runs through the membrane from one of its ends 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 tonality, the timbre and, in ordinary cases, the intensity"] (*PM* 33).

Comments: The experiment described here closely resembles the one documented in item 7 (q.v. on "cadences," "inflection," and "waves of condensation"). Scott notes that his conduit was modeled after the outer ear and mentions using the "handle of the hammer" to increase the tension of the membrane here and in item 19 (q.v.).

17. MOUVEMENT DE SFORZENDO SUR CHAQUE TON ca. October 1857

Bottom, in lampblack: **l'appogiatura. Etude sur l'intensité** [*strikeout and following text in ink*] **mouvement de sforzendo sur chaque ton** [~~appogiatura~~. Study of intensity | motion of sforzendo on each tone]

Margin, in ink: **Pl. V. Si l'on vient à renfler brusquement un son de voix, la membrane accomplit pendant la vibration un mouvement d'ondulation longitudinal très prononcé dans les distances de 30 à 40 centimètres.** [Pl. V. If one should happen abruptly to swell a sound of voice, the membrane carries out during the vibration a very pronounced motion of longitudinal undulation in distances of 30 to 40 centimeters.]

Physical Description: Paper, unmounted, helical single-trace.

Location: SEIN 8/54-5

Deposit: 28 October series (see item 13)

Comments: The 30-40 cm distance contrasts with the 50 cm distance mentioned in connection with items 6, 7, 20, and 21. Scott may have departed from usual practice due to the special interest he expresses here in studying dynamics.

18. VOCALISES / HURLEMENTS ET CRIS ca. October 1857

Beginning, in lampblack: **vocalises** → [vocalises→]

Along trace, in lampblack: **hurlements et cris:**→ [yells and cries:→]

Bottom, in lampblack: **dans le cri absence d'isochronisme : dans le chant le son est d'autant plus pur qu'il y a plus d'isochronisme** [in the cry absence of isochronism: in the song the sound is the purer the more isochronism there is]

Margin, in ink: **Pl. VI. Les mouvements brusques ^de totalité de l'air du tuyau qui se produisent dans le cri et le hurlements produisent des ressauts dans la membrane. Les vibrations ne sont pas isochrones comme dans la vocalise.** [Pl. VI. The abrupt motions ^of totality of the air of the pipe which are produced in the cry and the yells produce jumps in the membrane. The vibrations are not isochronous as in the vocalise.]

Location: SEIN 8/54-11

Deposit: 28 October series (see item 13)

Physical Description: Paper, unmounted, helical single-trace.

References: Scott states in his 28 October presentation: "Voici le tracé de cris explosifs, de hurlements comparés avec le chant. Je crois avoir constaté ce fait curieux qu'un son, soit d'un instrument, soit d'une voix, 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 discords d'une façon absolue" ["Here is the trace of explosive cries, of yells compared with singing. I believe I have noted the curious fact that a sound, be it of an instrument or 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. 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 sounds in an absolute way"] (*PM* 35).

Comments: This appears to be the first item in the discography which Scott conceived as presenting two contrastive subjects side by side, in this case one at the top of the sheet and one at the bottom; cf. item 31.

19. AFFOLLEMENT ca. October 1857

Bottom, in lampblack: **affollement d'une membrane fortement tendue par le marteau** [craziness of a membrane strongly stretched by the hammer]

Margin, in ink: **Pl. VII. quand la voix en montant ou descendant vient à rencontrer le ton propre ou fondamental du conduit, il se produit un affollement qui est une sorte de combinaison du mouvement de vibration avec le mouvement marqué dans la planche V.** [Pl. VII. when the voice in rising or descending happens to encounter the proper or fundamental tone of the conduit, it produces a craziness which is a sort of combination of the motion of the vibration with the motion shown in plate V.]

Physical Description: Paper, unmounted, helical single-trace.

Location: SEIN 8/54-9

Deposit: 28 October series (see item 13)

Comments: Scott mentions using the "handle of the hammer" to increase the tension of the membrane here and in item 16. He notes in his talk of 28 October that the "rôle de cet osselet de l'ouïe appelé le marteau" ["role of that ossicle of the ear called the hammer"] is an important issue but that he is reserving its discussion for a future time (*PM* 31). According to the writings of Félix Savart, which exerted a profound influence on the theoretical side of Scott's work, the handle of the hammer increases the tension of the eardrum to reduce its sensitivity when the ear is exposed to extremely intense sounds.[28] Like Savart, Scott may sometimes have introduced an artificial "handle of the hammer" to pull on his experimental membrane in order to reduce the amplitude of its vibrations. This interpretation would be consistent with an observation found in Scott's 1861 communication to the Académie des Sciences: "Une membrane qui n'est point...tirée vers son centre ne trace qu'imparfaitement son mouvement et s'*affolle* sous l'influence du ton propre au conduit" ["A membrane which is not...pulled towards its center traces its movement only imperfectly and goes *crazy* under the influence of the tone proper to the conduit"] (*PM* 74). Scott notes explicitly that item 19 displays "craziness," but perhaps his understanding was that the "handle of the hammer" had reduced it and that an unmodified membrane would have given even "crazier" results.

20. NOTRE PÈRE QUI ÊTES AUX CIEUX October 1857

Bottom, in lampblack: **notre père qui êtes aux cieux | Léon Scott octobre 1857** [our father who art in heaven | Léon Scott October 1857]

Margin, in ink: **Pl VIII. Trace obtenu sous l'influence de la parole | c'est l'oraison dominicale tout entière. Les modifications du tube oral sont indiqués par les mouvements de torsion de la membrane.** [Pl VIII. Trace obtained under the influence of speech | this is the whole Lord's Prayer. The modifications of the oral tube are indicated by the motions of torsion of the membrane.]

Location: SEIN 8/54-10

Deposit: 28 October series (see item 13)

Physical Description: Paper, unmounted, helical single-trace.

References: Scott states in his 28 October presentation, in connection with waves of inflection: "J'ai l'honneur d'en mettre une bonne figure sous vos yeux dans cette épreuve qui montre le tracé de l'oraison dominicale récitée d'une voix accentuée, à cinquante centimètres de la membrane" ["I have the honor of placing beneath your eyes a figure thereof in this *épreuve* which shows the trace of the Lord's Prayer recited in an accentuated voice fifty centimeters from the membrane"] (*PM* 33).

Comments: This is the only known phonautogram clearly dated October 1857 in the lampblack at the time of its recording. Judging from Scott's (apparently) recent promise to the SEIN – "Je compte mettre sous peu sous vos yeux...le tracé de la parole" ["I intend soon to place beneath your eyes...the trace of speech"] (*PM* 21) – it probably reflects a heightened interest in recording speech as opposed to singing, also manifested in items 21 and 22.

21. S'IL FAUT QU'À CE RIVAL (A) ca. early Nov. 1857

Bottom, in lampblack: **Déclamation écrite par la voix même : s'il faut qu'à ce rival..... terribles mains! L. Scott, 1857** [Declamation written by the voice itself: so it must be that to this rival..... terrible hands! L. Scott, 1857]

Underneath, in ink: **la voix a trop d'intensité pour la distance de 50 centimètres. Dans les mots pour lui, et tomber vivant formant explosion, le style s'est affolé et a quitté la couche sensible (voir la glose ci-joint).** [the voice has too much intensity for the distance of 50 centimeters. In the words *pour lui* and *tomber vivant* forming explosion, the stylus went crazy and left the sensitive stratum (see attached gloss)]; **Reçu le 16 9bre 1857 Ch A** [Received 16 Nov 1857 Ch A]

Location: SEIN 8/54-19

Deposit: with cover letter SEIN 8/54-18 *bis*, 16 November 1857.

Physical Description: Paper, mounted on a paper backing with two supplementary documents attached, helical single-trace, height ca. 19 cm. The top appears to have been trimmed across the trace specifically to remove the first two-thirds of the first rotation.

References: In the cover letter, Scott writes: "Je viens vous prier de vouloir bien recevoir, au nom de la Société d'Encouragement, les trois pièces suivantes et d'y apposer le cachet et la date" ["I am going to ask you to be so kind as to receive, in the name of the Société d'Encouragement, the three following pieces and to affix thereon the seal and the date"] (*PM* 43). In an attached "Note sur l'écriture phonautographique" ["Note on phonautographic writing"] dated 14 November 1857, Scott writes of "la tenue et la coulée du son, la voix saccadée, si bien formées dans la planche naturelle ci-jointe" ["the holding and the flow of the sound, the jerky voice, so well formed in the natural plate attached"] (*PM* 44).

Comments: The selection is from Jean-François Ducis, *Othello,* Act 4, Scene 2 – a test piece Scott used repeatedly. This particular item presumably predates 14 November 1857 (since it is referenced in a note bearing that date) and closely resembles item 22. The third of the three documents identified in the cover letter is a "Traduction en écriture figurative ordinaire de l'écriture phonautographique réprésentant l'intensité, la mesure, la tonalité, le timbre" ["Translation into ordinary figurative writing of phonautographic writing representing intensity, measure, tonality, timbre"] with a key showing what Scott believed to be corresponding waveform types (*PM* 45). A similar hand-drawn

illustration, also based on the *Othello* passage, appears as plate two in Scott's 1859 *certificat d'addition* (*PM* 66-67); George Brock-Nannestad has argued that this illustration must consist of tracings of parts of an actual phonautogram, basing this conclusion on a slant he identifies with the helix thread.[29] Item 38 is a phonautogram from 1860 of the same *Othello* passage, and item 41 may be as well.

22. S'IL FAUT QU'À CE RIVAL (B) ca. early Nov. 1857

Underneath, in pencil: **la déclamation écrite par la voix elle : même : s'il faut qu'à ce rival (voir la glose ci-jointe)** [declamation written by the voice itself: so it must be that to this rival (see attached gloss)]

Location: SEIN 8/54-35

Deposit: unknown; personal gift to Lissajous?

Physical Description: Paper, mounted on a paper backing with supplementary document attached, helical single-trace, height approx 16.7 cm.

Comments: This item closely resembles item 21 (q.v.), and the attached supplementary document is another "Traduction en écriture figurative" (*PM* 51).

23. GAMME DE DO À DO ca. November 1857

Bottom, in lampblack (circled): **gamme de do à do² puis de do² à do. Voix** [scale from do to do² then from do² to do. Voice]

Margin, in pencil: **les conduits de forme géométrique ont un ton propre qui affole la style : étude sur la tonalité** [conduits of geometrical form have a proper tone which makes the stylus go crazy: study of tonality]

Location: SEIN 8/54-20

Deposit: unknown, but items 23-27 (SEIN 8/54-20 through 24) may have formed a group; see also item 28; personal gift to Lissajous?

Physical Description: Paper, unmounted, helical multiple-trace.

Comments: This phonautogram apparently documents an ascending vocal scale followed by a descending vocal scale. Scott's pencil notation – presuming it is a comment on a problem with the phonautogram – emphasizes the catastrophic reinforcement of certain notes by the inherent resonant properties of the recording conduit. Scott had already drawn attention to this danger in document entitled "Graphie du son," dated 22 July 1857 and deposited with the Académie des Sciences on 27 July: "Toute forme géométrale ou régulière est impropre à un conduit acoustique qui ne doit être qu'un simple collecteur d'ondes sonores. Toute masse d'air incluse dans une forme géométrique aurait un son propre qui troublerait l'audition" ["Any geometrical or regular form is unsuited to an acoustic conduit which should be nothing but a simple *collector* of sound waves. Any mass of air enclosed in a geometrical form would have a proper tone which would confuse hearing"] (*PM* 19-20). By "geometrical or regular," Scott may mean such forms as ellipses and parabolas, which he had cited as possibilities in his 1857 *brevet d'invention* (*PM* 16).

24. CONDUIT DE PLÂTRE 25 November 1857

Bottom, in lampblack: **conduit de plâtre imitant les courbures du conduit externe : il n'a pas de ton propre sensible | Léon Scott 25 novembre** [conduit of plaster imitating the curves of the external conduit: it has no perceptible proper tone | Léon Scott 25 November]

Location: SEIN 8/54-21

Deposit: unknown, but items 23-27 (SEIN 8/54-20 through 24) may have formed a group; see also item 28; personal gift to Lissajous?

Physical Description: Paper, unmounted, helical multiple-trace.

Comments: This item was probably intended to contrast with item 23 and to eliminate the "craziness" described there through the substitution of a conduit modeled after the outer ear, as in item 16. In the 1859 *certificat d'addition,* Scott favors "matières insonores (plâtre coulé ou pâtes solidifiées)" ["non-sonorous materials (cast plaster or solidified pastes)"] for conduits on the grounds that they would not absorb vibrations before they could reach the membrane (*PM* 56), and in his presentation of 28 October he mentions using apparatus "en bois, en carton, en plâtre" ["of wood, of cardboard, of plaster"] (*PM* 39). This is one of only two phonautograms from 1857 associated with a specific day, the other being item 9.

25. TIMBRE DE LA VOIX ca. November 1857

Margin, in pencil: **étude sur le timbre de la voix | cette épreuve ne me satisfait pas** [study of the timbre of the voice | this *épreuve* does not satisfy me]

Location: SEIN 8/54-22

Deposit: unknown, but items 23-27 (SEIN 8/54-20 through 24) may have formed a group; see also item 28; personal gift to Lissajous?

Physical Description: Paper, unmounted, helical multiple-trace.

Comments: This could conceivably be one of the "timbre" phonautograms Scott deposited on 9 December 1857 (see item 29), but the note "this *épreuve* does not satisfy me" would seem to mark it as a reject.

26. L'ONDE D'INFLEXION : VOCALISES ca. November 1857

Bottom, in lampblack: **étude sur l'onde d'inflexion : vocalises** [study of the wave of inflection: vocalises]

Location: SEIN 8/54-23

Deposit: unknown, but items 23-27 (SEIN 8/54-20 through 24) may have formed a group; see also item 28; personal gift to Lissajous?

Physical Description: Paper, unmounted, helical single-trace.

Comments: This item has a close resemblance to item 27. On "vocalises," see item 13.

27. L'ONDE D'INFLEXION ca. November 1857

Bottom, in lampblack: **étude sur l'onde d'inflexion** [study of the wave of inflection]

Location: SEIN 8/54-24

Deposit: unknown, but items 23-27 (SEIN 8/54-20 through 24) may have formed a group; see also item 28; personal gift to Lissajous?

Physical Description: Paper, unmounted, helical single-trace.

Comments: This item has a close resemblance to item 26.

28. DIAPASON DONNANT 512 VIBRATIONS PAR SECONDE ca. November 1857

Along trace, in lampblack: **1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27** [*labeling segments of trace demarcated by perpendicular lines, all in the same rotation, third from the bottom of the sheet*]

Location: SEIN 8/54-25

Deposit: likely retained by Lissajous after the experiment. If items 23-28 (SEIN 8/54-20 through 25) formed a group, Lissajous may have obtained all six items on that same occasion.

Physical Description: Paper, unmounted, helical multiple-trace.

References: Lissajous states in his report of January 1858: "L'appareil de M. Scott paraît éminemment propre à compter le nombre de vibrations correspondant à un son donné. Pour nous en assurer nous avons fait tracer sur le cylindre les vibrations d'un diapason donnant 512 vibrations par seconde, et nous avons en même temps fait tracer par l'appareil lui-même le son rendu par un autre diapason, exactement d'accord avec le précédent. Les deux lignes sinueuses présentaient, sur une même longueur, rigoureusement le même nombre de vibrations, 222 de part et d'autre. Nous sommes convaincus, d'après cette expérience, que l'appareil de M. Scott peut servir à compter, avec une très-grande précision, le nombre des vibrations des sons produits dans l'air" ["The apparatus of Mr. Scott appears eminently suitable for counting the number of vibrations corresponding to a given sound. To assure ourselves of this, we caused to be traced on the cylinder the vibrations of a tuning fork giving 512 vibrations per second, and at the same time we caused the sound given by another tuning fork, exactly in accord with the preceding one, to be traced by the apparatus itself. The two sinuous lines presented, over the same length, strictly the same number of vibrations, 222 in both cases. We are convinced, in accordance with this experiment, that the apparatus of Mr. Scott can serve to count with very great precision the number of vibrations of sounds produced in the air"].[30]

Comments: Parallel traces in the same rotation of item 28 tend to display the same number of oscillations in the same linear space, "spreading out" and "tightening up" at the same rate, suggesting that both were recorded simultaneously from sound sources of the same frequency and were subject to the same rotational irregularities – as would have been the case in the experiment Lissajous describes. The number of cycles in each of the segments numbered 1 through 27 varies between four and fifteen, with the perpendicular lines separating the segments drawn in different parts of the cycle, creating some confusion. However, I count 223 cycles total, which under the circumstances is close enough to 222 to be considered a match. If Lissajous retained item 28 immediately after the experiment, this would explain why Scott did not label it.

29. TIMBRE DU CORNET À PISTON (A) ca. late Nov. / early Dec. 1857

Side, in pencil: **Timbre du Cornet à piston** [Timbre of the Cornet]

Location: SEIN 8/54-31

Deposit: probably with 8/54-18 (cover letter) and 8/54-37 (a page of notes), both dated 9 December 1857.

Physical Description: Paper, unmounted, helical multiple-trace.

References: The cover letter refers to "quatre nouvelles pièces expérimentales auxquelles s'attachera, je l'espère, un certain intérêt, puisqu'elles jettent du jour sur une

question bien obscure jusqu'à présent, celle du timbre" ["four new experimental pieces to which will be attached, I hope, a certain interest, since they cast light on a question hitherto quite obscure, that of *timbre*"] (*PM* 46).

Comments: The "four" pieces mentioned in the cover letter may be items 29-32 (SEIN 8/54-31 through 34), but this is not absolutely certain; item 25 could belong to the group instead, for instance. 8/54-37 contains some manually traced or redrawn examples of "figures du timbre du cornet à piston dans l'air à 25 centimètres de la membrane du tympan graphique" ["figures of the timbre of the cornet in the air at 25 centimeters from the membrane of the graphic tympanum"] (*PM* 47), presumably copied from item 29, item 30, and/or another, similar phonautogram.

30. TIMBRE DU CORNET À PISTON (B) ca. late Nov. / early Dec. 1857
Side, in pencil: **Timbre du Cornet à piston** [Timbre of the Cornet]
Location: SEIN 8/54-34
Deposit: see item 29
Physical Description: Paper, unmounted, helical multiple-trace.
Comments: see item 29

31. CRI DE RUGISSEMENT / CHANT late 1857
Bottom, in lampblack: **étude comparative du cri de rugissement et du chant = le chant est mis en interligne. Dans le chant les vibrations sont égales ou isochrones, dans le rugissement elles ne le sont pas. Regardez à la loupe, s. v. plait. | L. Scott** [comparative study of the shout of roaring and of song = the song is given in the interlinear space. In the song the vibrations are equal or isochronous, in the roar they are not. Examine with loupe, please. | L. Scott]
Location: SEIN 8/54-32
Deposit: see item 29
Physical Description: Paper, unmounted, helical multiple-trace.
Comments. This is the only known case in which Scott used the interlinear relationship between two traces for purposes of contrast. In 8/54-37, a note about timbre dated 9 December 1857, Scott mentions that one relevant distinction in the form of vibrations is "leur régularité ou leur irrégularité et leur isochronisme ou leur non-isochronisme" ["their regularity or irregularity and their isochronism or nonisochronism"] (*PM* 47). This is the point Scott seems to be trying to illustrate with item 31, so it may have been one of the four timbre-related phonautograms Scott deposited on 9 December 1857 with cover letter 8/54-18 (see item 29); however, see also item 18 in the 28 October series, which would already have made essentially the same point.

32. VOIX ET CORNET late 1857
Bottom, in lampblack: **voix et cornet sans déranger la position du style** [voice and cornet without disturbing the position of the stylus]
Along trace, in lampblack: "voix" and "cornet" at various spots to show transitions.
Location: SEIN 8/54-33
Deposit: see item 29
Physical Description: Paper, unmounted, helical multiple-trace; vertical lines drawn across trace to show points of transition between voice and cornet.

Comments: Scott states in his 28 October presentation: "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" ["I have gathered together a certain number of *épreuves* 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 *épreuves* of this kind in an upcoming session"] (*PM* 35). This passage indicates that Scott had already made some comparative voice-versus-cornet phonautograms as of 28 October. The distinction is arguably one of timbre, so item 32 may have been one of the four timbre-related phonautograms Scott deposited on 9 December 1857 with cover letter 8/54-18 (see item 29).

33. ÉTALONNAGE D'UN SON AU MOYEN DU CHRONOMÈTRE ca. mid 1859

Along trace, in lampblack, upside down relative to the usual orientation: **100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 2500 | 2600**

Margin, in ink: **Planche 3, représentant l'étalonnage d'un son au moyen du chronomètre, annexée à ma demande du 29 juillet 1859 d'un certificat d'addition à mon brevet d'invention délivré le 25 mars 1857 sous le nº 31470 pour un procédé d'écriture et de dessin par le son (acoustique).** [Plate 3, representing the calibration of a sound by means of the chronometer, appended to my request of 29 July 1859 for a certificate of addition to my patent of invention issued 25 March 1857 under the number 31470 for a process of writing and drawing by sound (acoustic).]

Location: INPI, plate included with Scott's *certificat d'addition* (*PM* 52-67), page number 15.

Deposit: with *certificat d'addition*, 29 July 1859.

Physical description: ca. 21.6 cm high, and with a trace pitch of ca. 1.6 cm. The interlinear space contains chronometer traces (straight lines, broken at first, then solid, then broken again) at two points, one near the beginning, the other about two thirds of the way to the end. A perpendicular line has been drawn through the "main" trace at the point where each chronometer trace begins. Between those two perpendicular lines, a dot appears over each cycle, with shorter perpendicular lines marking increments of ten and numbers written next to the trace at increments of 100. The second taller perpendicular line, marking the start of the second chronometer trace, falls on cycle 2,613.

References: In the *certificat d'addition,* Scott writes: "Le chronomètre pointeur employé dans l'appareil et destiné à étalonner un son de solide ou de fluide est celui imaginé par M. Redier. Une pointe préparée pour cet office porte un style souple qui est mis en contact avec le cylindre dans l'entreligne du tracé phonautographique. Un échappement le relève pendant une durée de 6 secondes. On obtient ainsi sur chaque bande des séries de 6 secondes; le sixième de chacune est le nombre de vibrations exécutées en une seconde de temps (Voir la planche 3)" ["The marking chronometer employed in the apparatus and intended to calibrate a sound of a solid or fluid is the one devised by Mr. Redier. A point prepared for this purpose carries a flexible stylus which is put in contact with the cylinder in the interline space of the phonautographic trace. An escapement

releases it for a duration of 6 seconds. Therefore series of 6 seconds are obtained on each strip; the sixth of each one is the number of vibrations carried out in a second of time (See plate 3)"] (*PM* 60-61).

Comments: The method Scott uses this plate to illustrate is described in print elsewhere in connection with traces left by a stylus attached directly to a sounding tuning fork.[31] However, it is uncertain whether item 33 was recorded in this way or via a membrane; Scott writes only of recording "a sound." David Giovannoni has pointed out that 2,613 cycles divided by six seconds gives a result of 435.5 Hz, which is as close as Scott's method could have come to 435.45 Hz, a measurement of the Diapason Normal at 15° C attributed to Rudolph Koenig.[32] A set of handwritten instructions furnished with a phonautograph in 1865 also accounts for the breaks in the interlinear chronometer traces and their significance in the counting of cycles: "Presque toujours en tombant sur le cylindre, la pointe rebondit d'abord plusieurs fois et trace ainsi une ligne discontinue, puis elle reste tranquillement appuyée sur le cylindre et y trace pendant quelque temps un trait continu; ensuite la pointe se relève et reste éloignée du cylindre jusqu'à ce qu'un nouvel échappement la fasse retomber sur ce dernier. Par conséquent, pour connaître le nombre de vibrations de la note, il faut compter les vibrations du commencement du premier trait discontinu jusqu'àu commencement du trait suivant, et diviser ce nombre par le nombre de secondes qui s'écoulent entre deux échappements" ["Almost always in falling onto the cylinder, the point initially bounces several times and thus traces a broken line; then it remains quietly pressed onto the cylinder and traces a continuous line thereon for some time; then the point is raised and remains distant from the cylinder until a new escapement makes it fall back onto the latter. Consequently, to know the number of vibrations of the note, it is necessary to count the vibrations from the beginning of the first discontinuous line until the beginning of the following line, and to divide this number by the number of seconds which pass between two escapements"].[33] The upside down orientation of the numbers relative to Scott's usual practice may reflect his effort to reach across as little of the paper as possible while counting cycles to minimize the risk of brushing the unfixed lampblack with his arm.

34. HOMMAGE À M. LE PROFESSEUR REGNAULT (fragments) — mid-to-late 1859 or early 1860

Top fragment, along trace, in ink: **diapason de 500 vibr. simpl. | harmoniques d'un son de voix** [tuning fork of 500 simple vibrations | harmonics of a sound of voice]

Middle fragment, side, in ink: **le ton fondamental avec harm. | diapason** [fundamental tone with harmonics | tuning fork]

Bottom fragment, side, in ink: **diapason de 500 v. s. écriv. simultan. son fondament. avec harmoniques.** [tuning fork of 500 simple vibrations writing simultaneously fundamental sound with harmonics.]

Underneath, in ink: **hommage à M. le professeur Regnault | Léon Scott | 28 mars 1860** [compliments to Professor Regnault | Léon Scott | 28 March 1860]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [2].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Three fragments mounted to a sheet of paper, unbound. In each case, Scott has labeled one rotation of a pair of traces, one representing the voice, one representing a tuning fork. Each fragment also contains one or more other traces in addition to the ones Scott has marked, giving the appearance of a sheet reused for multiple experiments.

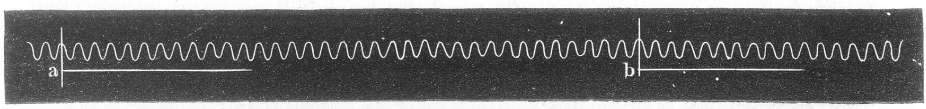

Figure 4a. *Illustration of the use of a marking chronometer to measure the frequency of a sound, from Johann Müller,* Lehrbuch der Physik und Meteorologie, *2 vols. (Braunschweig: Friedrich Vieweg und Sohn, 1862-63), 1:440, author's collection.*

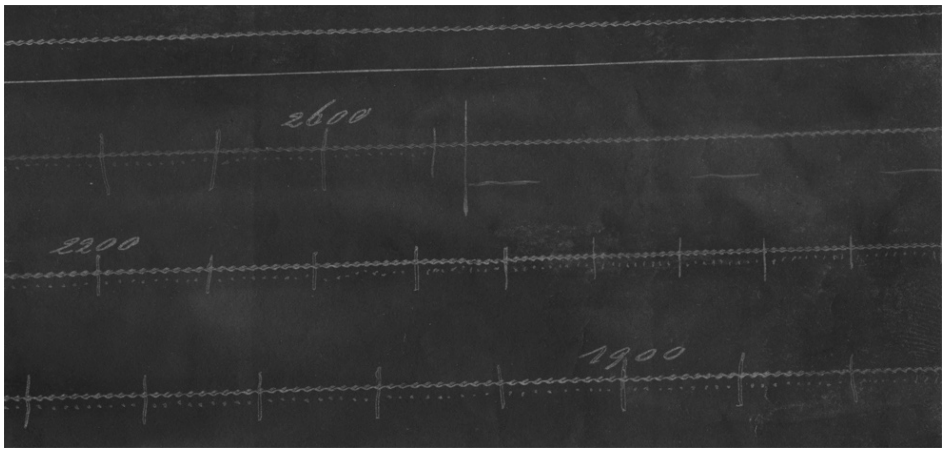

Figure 4b. *Detail of a phonautogram in which Scott used a marking chronometer to measure the frequency of a sound. As oriented here, the trace of the sound was made from left to right and from bottom to top, with the chronometer positioned to mark below it. Following a series of cycles marked off in groups of ten, Scott has drawn a taller vertical line at the point where the chronometer stylus initially struck the lampblack when released for the second time, "skipping" at first and then drawing a solid line. This taller vertical line is equivalent to the line b in Fig. 4a (item 33, FirstSounds.org).*

Comments: This is the earliest dated document containing vocal phonautograms with tuning-fork timecode, an innovation Scott credited to his collaboration with Rudolph Koenig in 1859.[34] Scott presented all three fragments to Regnault as illustrating vocal harmonics (on which see also item 41).

35. DIVERS MOUVEMENTS INSCRITS AUTOMATIQUEMENT (fragments) — mid-to-late 1859 or 1860

Underneath top center plate, in ink: **figure d'une sorte de grognement sur la voyelle in avec diapason de 500 en entreligne.** [figure of a sort of growl on the vowel *in* with tuning fork of 500 in interlinear space.]

Underneath middle center plate, in ink: **2 voix simultanés l'un fait le si^2, l'autre l'ut^3** [2 simultaneous voices the one does *si*^{2}, the other *do*^{3}]

Underneath bottom center plate, in ink: **un des harmoniques de la voix** [one of the harmonics of the voice]

Underneath top right plate, in ink: **la voyelle a chantée avec diapason en entreligne** [the vowel *a* sung with tuning fork in interlinear space]

Underneath bottom right plate, in ink: **figure et durée d'un choc simple sur une plaque de fer blanc transmis par l'air avec diapason simultané en entreligne.** [figure and duration of a simple impact on a sheet of tin-plate transmitted by the air with simultaneous tuning fork in interlinear space.]

Bottom: **Léon Scott, b. s. g. d. g.** [i.e., "brevet sans garantie du gouvernement": Léon Scott, patent without governmental guarantee]

Location: Archives of the Académie des Sciences, page [6] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Five phonautogram fragments attached to a sheet of paper, of which those with labels mentioning tuning-fork timecode have it; the others do not. To the left of the plates listed above are three more inscriptions made by tops or teetotums. If we include these, there are eight fragments total attached to the sheet.

References: In the accompanying manuscript, Scott identifies this plate as "divers mouvements inscrits automatiquement" ["various motions automatically inscribed"] (*PM* 71).

Comments: This item resembles one of the first published sets of phonautogram fragments, found in the ninth edition of Adolphe Ganot's *Traité élémentaire de physique expérimentale et appliquée et de meteorologie* (1860), which might also have been Scott's work: "La figure 152 montre le trace d'un ton simple chanté, renforcé par son octave supérieure, représentée par la courbe de moindre amplitude. La figure 153 donne le son de deux tuyaux sonores à l'octave. La figure 154, dans sa ligne inférieure, représente le roulement de la lettre R grasseyée; et la figure 155, aussi dans sa ligne inférieure, correspond au bruit que fait entendre une plaque de fer-blanc qu'on frappe avec le doigt" ["Figure 152 shows the trace of a simple sung tone, strengthened by its upper octave, represented by the curve of lesser amplitude. Figure 153 gives the sound of two sounding pipes an octave apart. Figure 154, in the lower line, represents the letter R spoken gutturally; and figure 155, also in the lower line, corresponds to the sound caused to be heard by a sheet of tin-plate which is struck with the finger"].[35] Note the presence of fragments illustrating the sound of a struck tin sheet in both groups. On the *r grasseyé* mentioned in Ganot, see item 42.

36. AU CLAIR DE LA LUNE (a) 9 April 1860

Bottom, in lampblack: **au clair de la lune chanté; la ton est mesuré par le diapason de 500 vibrations simples par seconde qui écrit directement et simultanément en entreligne du chant | Léon Scott 9 Avril 1860** [au clair de la lune sung; the tone is measured by the tuning fork of 500 simple vibrations per second which writes directly and simultaneously in interlinear space of the song | Léon Scott 9 April 1860]

Margin, in red pencil: **№ 5.**

Margin, in ink: **Chant de la voix par la membrane du tympan fixée à son centre. Le Diapason écrit simultanément en entreligne.** [Song of the voice by the membrane of the tympanum fixed at its center. The tuning fork writes simultaneously in interlinear space.]

Location: Archives of the Académie des Sciences, page [9] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, unmounted, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "chant de la voix par la membrane du tympan fixée à son centre, également avec diapason" ["song of the voice by the membrane of the tympanum fixed at its center, likewise with tuning fork"] (*PM* 71-72).

Comments: This is the earliest known complete Scott phonautogram of the human voice with timecode. "Au Clair de la Lune" appears to have been one of Scott's favorite test pieces in this period; other known examples are items 37 and 44. The inscription in the lampblack indicates that Scott originally produced this phonautogram as a study of "tone," in the sense of "pitch." The ink inscription made at the time of assembly for deposit instead emphasizes the use of a membrane "fixée à son centre" ["fixed at its center"], a notation also found in the ink inscription on item 46. The phrase *fixée à son centre* was also used in connection with Chladni plates,[36] and in the context of phonautography it probably meant the analogous practice of resting a pin against a point on the membrane in an effort to modify its nodal patterns and to ensure that the stylus was not attached to a node. This adjustable pin, the "subdiviseur de la membrane" ["subdivider of the membrane"], is described in the *certificat d'addition* of 1859 (*PM* 55-56). Scott writes further: "Cette pièce dont je n'accepte pas la responsabilité, est la réalisation d'une théorie de Chladni et de Savart. Elle est due à M. Kœnig" ["This part, for which I do not take responsibility, is the realization of a theory of Chladni and Savart. It is due to Mr. Koenig"].[37] In the case of items 36 and 46, the "subdivider" pin apparently rested on the center of the membrane – possibly its default position.

37. AU CLAIR DE LA LUNE (b) 17 April 1860

Bottom, in lampblack: **au clair de la lune, avec diapason écrivant simultanément et directement en entreligne | 17 avril 1860** [au clair de la lune, with tuning fork writing simultaneously and directly in interlinear space | 17 April 1860]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [4].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: On the selection, see item 36.

38. S'IL FAUT QU'À CE RIVAL (c) 17 April 1860

Bottom, in lampblack: **effet acoustique de la déclamation avec diapason simultané pour montrer les flexions de l'intonation** [acoustic effect of declamation with simultaneous tuning fork to show the inflections of the intonation]; **s'il faut qu'à ce rival hédelmone infidèle | Ait remis ce bandeau / dans leur rage cruelle | Nos lions du désert sous leur antre brûlant –** [so it must be that to this rival faithless hédelmone | Gave this diadem / in their cruel rage | Our lions of the desert under their burning lair –]; **Léon Scott | 17 avril 1860** [Léon Scott | 17 April 1860]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [6].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: On the selection, see item 21. Scott's stated objective here was to document changes of pitch in declamation.

39. GAMME DE LA VOIX (a) 18 April 1860

Bottom, in lampblack: **gamme de voix avec diapason de 500 vibrations simples en entreligne | 18 avril (bis)** [scale of the voice with tuning fork of 500 simple vibrations in interlinear space | 18 April (#2)]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [3].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: All known phonautograms recorded on 18 April (items 39-42) have the notation "bis" (i.e., "#2"), while the only known phonautogram recorded on 19 April (item 43) has the notation "ter" (i.e., "#3"). Perhaps Scott recorded a series of subjects on 17 April, recorded them again as "second takes" on 18 April, and recorded some yet again as "third takes" on 19 April; or perhaps he was simply numbering days for clarification (i.e., 18 April was day #2 of these experiments, and 19 April was day #3). Scott had recorded vocal scales before (items 16 and 23) and was to do so again (item 46).

40. D'ACCORD PARFAIT 18 April 1860

Bottom, in lampblack: **d'accord parfait | 18 avril (bis)** [of a tonic chord | 18 April (#2)]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [5v].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode. Item 44 occupies the "front" side of the same sheet of paper. Item 40 has a blackened width of ca. 42 cm, indicating that a ca. 11 cm strip has been cropped off the left side; this presumably happened when the sheet was prepared for the recording of item 44.

Comments: on the notation "bis," see item 39. One or more words before "d'accord parfait" may have been removed when the sheet was cropped.

41. LA MÊME DECLAMATION 18 April 1860

Bottom, in lampblack: **La même déclamation pour montrer quelques-un des harmoniques | 18 avril (bis)** [The same declamation to show some of the harmonics | 18 April (#2)]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [7].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: Scott's stated objective of showing vocal harmonics reflects the same research interest he had illustrated fragmentarily for Regnault in item 34; see also item 46. This may be the "same" declamation as item 38, which immediately precedes it in the Regnault papers, but it might also be the "same" as whatever Scott had recorded immediately before it (cf. item 43, which is labeled "the same" but has content not corresponding to anything else in the Regnault papers, showing that original lampblack notations could lose their points of reference when phonautograms were reorganized with new contexts in mind). On the notation "bis," see item 39.

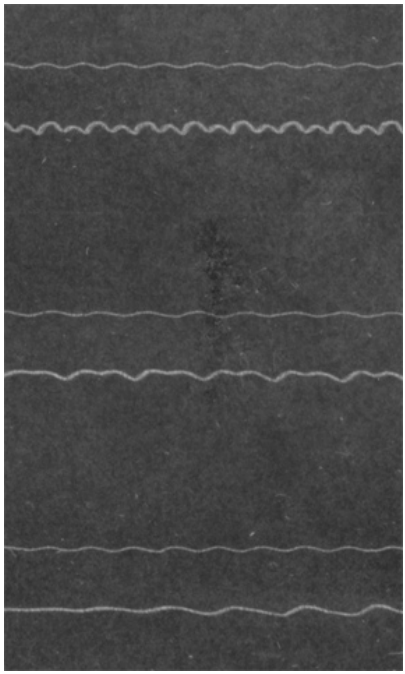

Figure 5. *Detail of three successive rotations of a trace-plus-timecode phonautogram. The upper traces represent a 250 Hz tuning fork, and the lower traces represent the voice (item 44, FirstSounds.org).*

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42. ÉPELLATION DU MOT *RIRA* 18 April 1860

Bottom, in lampblack: **épellation du mot rira avec l' r grasseyé pour montrer comment la consonne s'appuie sur la voyelle | Léon Scott | 18 avril (bis)** [spelling of the word *rira* with the r spoken gutturally to show how the consonant rests on the vowel | Léon Scott | 18 April (#2)]

Along trace: **re | i | ri | re | a | ra | rira | re | i | ri | re | a | ra | rira | re | i | ri | re | a | ra | rira**

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [8].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: The word *rira* means "will laugh." Judging from the inscriptions along the trace, the same sequence is repeated three times: *R, I, RI, R, A, RA, RIRA.* The breakdown by syllables and the use of the name "re" for the letter *r* is consistent with *la nouvelle épellation* ("the new spelling"), a proposed educational reform that was never widely adopted. The term *r grasseyé* traditionally refers to a uvular *r* (cf. the comments on item 35), and Scott's stated objective here was to study the combination of this distinctive speech sound with vowels. On the notation "bis," see item 39.

43. LE JOUR NÊ PA PLUS PUR KE LE FON DE MON KEUR 19 April 1860

Bottom, in lampblack: **la même (membrane enduite par le procédé indiqué par M le professeur Regnault) | 19 avril (ter)** [the same (membrane coated by the process indicated by Professor Regnault) | 19 April (#3)]

Along trace, in lampblack: "[*unlabeled syllable*] | **jour | nê | pa | plus | pur | ke | le | fon | de | mon | keur | Le | jour | nê | pa |** [*unlabeled syllable*]"

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [9].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode.

Comments: In standard French orthography, the line is "Le jour n'est pas plus pur que le fond de mon cœur" (Jean Racine, *Phèdre*, Act IV, Scene 2); in English, "The day is no more pure than the depth of my heart." The phonautogram evidently contains the line spoken once all the way through, and then a second time up through the word "plus." Scott's father had used this same line for stenographic experiments in the 1840s and had chosen it because it consists solely of monosyllabic words.[38] On the "coating" of the membrane see item 45, and on the notation "ter" see item 39.

44. AU CLAIR DE LA LUNE (c) 20 April 1860

Bottom, in lampblack: **la même expérience (au clair de la lune) avec le timbre indiqué / inclinaison naturelle du tympan; fenêtre ovale; caoutchouc | 20 avril L S[co]tt** [the same experiment (au clair de la lune) with the timbre shown / natural inclination of tympanum; oval window; caoutchouc | 20 April L Scott]

Location: Library of the Institut de France, Regnault Papers, Ms. 2935, leaf [5r].

Deposit: unknown; gift to Henri-Victor Regnault.

Physical Description: Paper, unmounted but bound, helical trace-plus-timecode. Item 40 occupies the "back" side of the same sheet of paper.

Comments: The "natural inclination" of the tympanum – i.e., that found in the human ear – is oblique rather than perpendicular with respect to the axis of the conduit (cf. item 13). Scott's reference to an "oval window" implies that he has now introduced a second membrane analogous to this part of the ear, as he had envisioned in early 1857 (*PM* 4-18, passim). Perhaps this experiment reflects some part of the advice from Regnault to which Scott refers in his 1861 communication to the Académie: "c'est...à lui que je dois les conseils qui me permettent aujourd'hui de soumettre à l'Académie l'appareil artificiel de la chaîne des osselets" ["it is...to him that I owe the counsels that today allow me to submit to the Académie the artificial apparatus of the chain of the ossicles"] (*PM* 71). Scott's inscription further reveals that he believed this item documented timbre to a degree his earlier efforts had not. On the selection, see item 36.

45. CHI CREDERIA CHE SOTTO FORME UMANE ca. April-May 1860

Bottom, in lampblack: **étude sur l'accent tonique à la requête de M. le professeur Regnault Chi crederia che sotto forme umane* e sotto queste pastorali spoglie fosse nascosto un Dio? non mi –** [Study of the tonic accent at the request of Professor Regnault. Chi crederia che sotto forme umane* e sotto queste pastorali spoglie fosse nascosto un Dio? Non mi –]; ***je me suis trompé | il faudrait umane forme** [*these last two words touched up in ink*; *I was wrong | it should be umane forme]

Bottom, in ink: **Léon Scott**

Margin, in red pencil: **№ 8.**

Margin, in ink: **Membrane du tympan, à trois tuniques d'élasticités compensées.** [Membrane of the tympanum, with three tunics of compensated elasticities.]

Location: Archives of the Académie des Sciences, page [12] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, unmounted, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "étude sur l'accent tonique par une membrane du tympan formée de trois tuniques à élasticités compensées" ["study of the tonic accent by a membrane of the tympanum formed of three tunics with compensated elasticities"] (*PM* 72). He also explains the rationale behind this arrangement: "La membrane de mon tympan artificiel doit être composée de plusieurs tuniques d'élasticités différentes, soudées ensemble; car elle ne doit sonner sous l'influence d'aucun son, et n'exécuter jamais librement ʌ^le ton qui est propre à leur élasticité naturelle, à leur état actuel de tension, mais seulement ~~aux~~ ʌ^les tons accomplis par l'air vibrant dans le conduit" ["The membrane of my artificial tympanum must be composed of several tunics of different elasticities, soldered together; because it must not *sound* under the influence of any sound nor ever execute freely ʌ^the tone which is peculiar to their natural elasticity, in their current state of tension, but only ~~to the~~ ʌ^the tones carried out by the air vibrating in the conduit"] (*PM* 74).

Comments: The selection is the opening of Torquato Tasso's *Aminta*, in Italian, intended as a study of the "tonic accent," meaning pitch-based rather than volume-based stress. Although Scott's notation indicates that this item was produced "at the request of Professor Regnault," Scott apparently retained it until its eventual deposit with the Académie. The multiple-tunic membrane design may have had some relationship with the method of "coating" membranes recommended by Regnault (see items 43 and 46); perhaps the "coating" was intended to serve a similar purpose. Scott notes that he was "wrong" about the order of two words in the recitation, and since the words are audibly inverted in the phonautogram itself, this provides circumstantial evidence that the recorded voice is Scott's own – though it is also conceivable that he had furnished an incorrect text for somebody else to recite.

46. GAMME DE LA VOIX (b) 17 May 1860

Bottom, in lampblack: **Gamme de la voix avec diapason de 500 vibrations simples en interligne pour compter, les harmoniques sont indiqués dans la vibration principale, membrane enduite d'après les indications de M. le professeur Regnault | 17 Mai 1860 | Léon Scott** [Scale of the voice with tuning fork of 500 simple vibrations in interlinear space for counting, the harmonics are indicated in the principal vibration, membrane coated according to the instructions of Professor Regnault | 17 May 1860 | Léon Scott]

Margin, in red pencil: **№ 3.**

Margin, in ink: **Gamme de la voix, par la membrane du tympan fixée à son centre. Le diapason écrit simultanément en entreligne.** [Scale of the voice, by the membrane of the tympanum fixed at its center. The tuning fork writes simultaneously in interlinear space.]

Location: Archives of the Académie des Sciences, page [7] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, unmounted, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "gamme de la voix ~~fixée~~ par la membrane du tympan fixée à son centre" ["scale of the voice ~~fixed~~ by the membrane of the tympanum fixed at its center"] (*PM* 71).

Comments: See item 36 on the use of a membrane "fixed at its center," item 45 on the "coating" of the membrane, item 41 on the study of vocal harmonics, and item 39 on the recording of vocal scales.

47. ET INCARNATUS EST DE CHÉRUBINI 1 September 1860

Bottom, in lampblack: **un chant de la voix (et incarnatus est de Chérubini) écrit par un solide (la platine de l'étrier) formant un nœud fixe dans la fenêtre ovale | Léon Scott | 1er Sept 1860** [a song of the voice (et incarnatus est by Chérubini) written by a solid (the footplate of the stirrup) forming a fixed node in the oval window | Léon Scott | 1st Sept 1860]

Bottom, in ink: **Vu le 7 ~~7~~bre 1860 A. Gérardin prof. de Physique au Collège Stanislas. | Vu le 7 Septembre 1860 Saigey** [Seen 7 September 1860 A. Gérardin prof. of physics at the Collège Stanislas. Seen 7 September 1860 Saigey]

Margin, in pencil: **ne pas couper en [...] bas l'écriture** [do not cut the writing at... bottom]

Location: Archives of the Académie des Sciences, page [13] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, unmounted, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "nº 9, l'inscription automatique du chant par l'étrier (épreuve visée le 7 7bre 1860 par MM. Gérardin et Saigey)" ["no. 9, the automatic inscription of song by the stirrup (*épreuve* signed on 7 September 1860 by Messrs. Gérardin and Saigey)"], and notes further: "J'ai joint au présent envoi une épreuve dont la date est ~~visée~~ certifiée par le visa de deux savants, M.M. Gérardin et Saigey" ["I have enclosed with the present parcel an *épreuve* of which the date is certified by the signature of two scientists, Messrs. Gérardin and Saigey"] (*PM* 72). Elsewhere in the same document, Scott explains the rationale behind his insertion of artificial ossicles as follows: "La phonométrie n'existant pas encore, on ne s'était pas aperçu de l'énorme différence d'amplitude qui existe entre les vibrations musicales, telles que celles de la trompette, du chant de la voix, etc., et les sifflements et les bruits, tels, les frôlements, certaines articulations, etc. Pour amplifier ceux-ci et atténuer celles-là, la nature s'est servie d'artifices acoustiques. – Le ~~principal~~ moyen principal de cette espèce de compensation, c'est la chaîne des osselets. Cette chaîne, que je vous présente artificiellement construite, est un appareil de tension des membranes et de conduction par voie de solide; c'est un arc à la fois flexible et bandé qui, par sa tension, produite par deux muscles antagonistes l'un du marteau, l'autre de l'étrier, opère à ses deux extrémités un tirage sur les membranes du tympan et de la fenêtre ovale, en les bandant elles-mêmes" ["*Phonometry* not yet existing, one had not realized the enormous difference in amplitude that exists between musical *vibrations,* such as those of the trumpet, the song of the voice, etc., and hissings and *noises,* such as rustlings, certain articulations, etc. To amplify the latter and attenuate the former, nature is served by acoustic contrivances.

The principal means of this kind of compensation is the chain of the ossicles. This chain, which I present to you artificially built, is an apparatus for stretching the membranes and conducting by way of a solid; it is an arc at once flexible and bent which, by its tension, produced by two opposed muscles, the one of the hammer, the other of the stirrup, effects at both its ends a pull on the membranes of the tympanum and of the oval window, in bending themselves"] (*PM* 74).

Comments: The selection appears to be "Et Incarnatus Est" from the *Missa Solemnis* in D minor by Luigi Cherubini.[39] This item seems to mark a point of crisis in Scott's phonautographic work. On 27 August 1860, Justin Bourget and Félix Bernard had presented findings to the Académie des Sciences which they framed as disproving Savart's theory of the vibratory properties of membranes – the key theoretical basis on which Scott's phonautograph rested.[40] Scott's introduction of the artificial chain of ossicles, and his explanation of its significance, may be interpretable as an attempt to answer their critique. If so, that might explain why he considered item 47 important enough to seek out formal witnesses for it; one was Auguste-Charles Gérardin,[41] and the other was probably Émile Saigey. The reference to the "oval window" indicates that the apparatus Scott used to record this phonautogram incorporated a second membrane at the end of the artificial chain of ossicles, as depicted in some published illustrations.[42]

48. GAMME DE LA VOIX (c) ca. early Sept. 1860

Bottom, in lampblack: **Gamme de la voix par l'oreille moyenne (fenêtre ovale)** [Scale of the voice by the middle ear (oval window)]

Margin, in red pencil: **№ 4.**

Margin, in ink: **Gamme par la platine de l'étrier, le Diapason écrit simultanément en entreligne.** [Scale by the footplate of the stirrup, the tuning fork writes simultaneously in interlinear space.]

Location: Archives of the Académie des Sciences, page [8] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, unmounted, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "nº 4 [*written over '3'*] gamme par la platine de l'étrier, également avec diapason" ["no. 4, scale by the footplate of the stirrup, likewise with tuning fork"] (*PM* 71).

Comments: The references to the "oval window" and the "footplate of the stirrup" point to the same recording setup Scott used to make item 47 (q.v.). On the recording of vocal scales, see item 39.

49. VOLE, PETITE ABEILLE (a) 15 September 1860

Underneath, in pencil: **vole, petite abeille – membrane simple – L'étrier écrit à l'air libre | L Scott 15 Sept. 1860** [vole, petite abeille – simple membrane – The stirrup writes in the free air | L Scott 15 Sept. 1860]

Underneath, left corner, in pencil: **No. 2** [*corrected from "No. 1"?*]

Underneath, right corner, in pencil: **vole/**

Side, in red pencil: **№ 6.**

Side, in ink: **Chant de la voix, écrit par la platine de l'étrier, dépouillée de sa membrane. Diapason en entreligne.** [Song of the voice, written by the footplate of

the stirrup, stripped of its membrane. Tuning fork in interlinear space.]

Location: Archives of the Académie des Sciences, page [10] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, mounted on backing paper, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "chant de la voix écrit par la platine de l'étrier artificiel dépouillé de sa membrane, avec diapason" ["song of the voice written by the artificial footplate of the stirrup stripped of its membrane, with tuning fork"] (*PM* 72).

Comments: The selection here and in item 50 is "La Chanson de l'Abeille," from *La reine Topaze* by Victor Massé.[43] The melody was identified through playback,[44] which also reveals that Scott used the same abridgement or "edit" for both items 49 and 50. Scott's reference to a "simple membrane," and to the "stripping" of the membrane from the footplate of the stirrup, indicates that the apparatus used to make this phonautogram omitted the artificial oval window used for items 47 and 48, leaving the end of the artificial chain of ossicles dangling out "in the free air," as depicted on page 4 of the accompanying manuscript.

50. VOLE, PETITE ABEILLE (b) ca. mid-to-late Sept. 1860

Underneath, in pencil: **un chant (vole, etc.) écrit par un solide, la platine de l'étrier à l'extrémité de la chaîne des osselets avec diapason compteur** [a song (vole, etc.) written by a solid, the footplate of the stirrup at the end of the chain of the ossicles with measuring tuning fork]

Underneath, right corner, in pencil: **No. 3** [*corrected from "No. 2"*]

Side, in red pencil: **№ 7.**

Side, in ink: **Chant de la voix écrit par la platine de l'étrier, à l'extremité de la chaîne des osselets, avec diapason compteur et style amplificateur.** [Song of the voice written by the footplate of the stirrup, at the end of the chain of the ossicles, with measuring tuning fork and amplifier stylus.]

Location: Archives of the Académie des Sciences, page [11] attached to "Inscription automatique des sons de l'air," manuscript no. 324 *bis*.

Deposit: with "Inscription automatique des sons de l'air" manuscript, 15 July 1861.

Physical Description: Paper, mounted on backing paper, helical trace-plus-timecode.

References: In the accompanying manuscript, Scott identifies this plate as "chant de la voix écrit par la platine de l'étrier à l'extrémité de la chaîne des osselets, avec diapason compteur et style amplificateur" ["song of the voice written by the footplate of the stirrup at the end of the chain of the ossicles, with measuring tuning fork and amplifier stylus"], and notes further: "Le style amplificateur que j'ai l'honneur de vous soumettre m'a permis de donner aux mouvements trop faibles de l'étrier les dimensions nécessaires" ["The amplifier stylus which I have the honor of submitting to you has enabled me to give to the too-weak motions of the stirrup the necessary dimensions"] (*PM* 72). The amplifying lever is depicted and described on page 4 of the same document (*PM* 75).

Comments: On the selection, see item 49. Item 50 contrasts with item 49 only by introducing the amplifying lever and so represents the last known stage in Scott's development of the phonautograph.

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Appendix

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Endnotes

1. The rumor can be traced back to Louis Hertz, *Antique Collecting for Men* (New York: Hawthorn Books, [1969]), 269-70, where it is characterized as a "legend" in which Thomas Edison destroyed the recording during a bungled playback attempt. For later versions, see Katie Hafner, "A Collector in Love With Technology, as Long as It's Dusty," *New York Times*, 25 March 1999, pp. G1, G8; and Brad Smith, *Busted Flush: A Novel* (New York: Henry Holt and Co., 2005), 200.

2. Parenthetical citations to *PM* refer throughout to Patrick Feaster, ed. and transl., *The Phonautographic Manuscripts of Édouard-Léon Scott de Martinville* (Bloomington, Indiana: FirstSounds.org, Dec. 2009).

3. Regarding his own work on phonautography, see Jean-Paul Agnard, "Working Phonautograph," *Antique Phonograph News* 2004(Sept.-Oct.); "Phonautographe Replica," *The Sound Box* 2008;26.2(June):32.

4. In particular, Édouard-Léon Scott de Martinville, *Le Problème de la parole s'écrivant elle-même* (Paris: chez l'auteur, May 1878), 48, mentions a sealed packet containing *épreuves* deposited with the "Institut" in January 1857 that were then already four years old, and this struck me as likely to refer to the sealed packet deposited with the Académie des Sciences de l'*Institut* de France that same month.

5. For a narrative of events written retrospectively in the form of a journal, see David Giovannoni, "The Phonautogram Diaries," *The Sound Box* 2008;26.2(June):3-6.

6. The outcome of this work includes George Brock-Nannestad, "150 Years of Time-Base in Acoustic Measurement and 100 Years of Audio's Best Publicity Stunt – 2007 as a Commemorative Year," Audio Engineering Society convention 122, 2007(May), paper 7007; George Brock-Nannestad, "Prosody in French theatrical declamation traced backwards in time," *Proceedings of Acoustics'08 Paris* (http://intellagence.eu.com/acoustics2008/acoustics2008/cd1), 2399-2404; George Brock-Nannestad and Jean-Marc Fontaine, "Early Use of the Scott-Koenig phonautograph for documenting performance," *Proceedings of Acoustics'08 Paris*, 6239-6244.

7. See e.g., Jody Rosen, "Researchers Play Tune Recorded Before Edison," *New York Times,* 27 Mar. 2008, pp. A1, A20, also reprinted in *Best Music Writing 2009*, ed. Daphne Carr (Da Capo Press, 2009), 80-85; Adam Sherwin, "Listeners join in joke as helpless BBC announcer gets a fit of the giggles," *London Times,* 29 Mar. 2008, p. 5.

8. "Catalogue en ligne des archives et des manuscrits de l'enseignement supérieur" (calames.abes.fr), with entry: "Manuscrits de l'Institut de France: Manuscrits de la Bibliothèque de l'Institut de France: Ms 2821-2936 Papiers de Victor Regnault: Ms 2931-2935 Notes et travaux divers: Ms 2935... « Fixation du chant », diagrammes de Léon Scott, 1860."

9. On 7 December 2009, after the first draft of this discography had been completed, David Giovannoni and Katherine Sheram made high-resolution scans of Ms. 2935. I have made a few revisions based on information gathered at that time.

10. One such communication was reprinted in Scott de Martinville, *Problème*, 38ff.

11. Andrew J. Butrica, "Historical Collections in Jeopardy: The Société d'Encouragement pour l'Industrie Nationale," *Isis* 1997;88(June):296-301.

12. A first-hand account of this episode, and others in this period, appears in David Giovannoni, "Adventures in Archeophony," Association for Recorded Sound Collections annual conference, Washington DC, 29 May 2009 (audio available at arsc-audio.org).

13. However, there do appear to be exceptions. For example, the extremities of the parallel traces in items 10 and 15 line up at the bottom, as though Scott had started both from the same point, and one trace in item 10 occupies only the lowest few rotations, as though Scott had started recording from the bottom and stopped prematurely. Still, items 10 and 15 are also exceptional for another reason: they were made using a stylus attached directly to an ashen pipe rather than to a membrane, which may have necessitated a different arrangement of apparatus. There are some further clues we might use to assess the direction of recording, such as the characteristics of the trace at the edges corresponding to the original join: whenever the trace consistently shows a deflection on one side of the join but not the other, I believe we can safely conclude that the stylus was jarred by passing over the bump and that it was therefore moving from the undeflected edge towards the deflected edge.

14. SEIN 8/54-13 has its margin on the left when the inscription scratched in the lampblack is right side up; however, this is not a phonautogram (and thus not included in the discography) but a record of the motions of a teetotum on an inclined plane, so Scott would have used the cylinder in this case only as a convenient means of blackening the sheet. Item 33 is also an exception, as discussed in that entry.

15. The report was published as "Rapport fait par M. Lissajous, au nom du comité des arts économiques, sur les essais phonographiques de M. Scott, rue Taranne, 6," *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* 1858;2ser.5:141-145. On Scott's association with the SEIN in general, see Serge Benoit, Daniel Blouin, Jean-Yves Dupont, Gérard Emptoz, "Chronique d'une invention: le *phonautographe* d'Édouard-Léon Scott de Martinville (1817-1879) et les cercles parisiens de la science et de la technique," *Documents pour l'histoire des techniques* 2009;17(June):69-89.

16. Hence the characterization of the set as "6 original and 2 photographic reproductions" in the appendix to *Édouard-Léon Scott de Martinville's 1861 Communication to the Académie des Sciences,* First Sounds Working Paper 4 (FirstSounds.org: 24 April 2008), 16.

17. For an account of how this work fits into the broader IRENE program at Lawrence Berkeley National Laboratory, see Carl Haber, "Imaging Historical Voices," *International Preservation News* 2008;46(Dec.):23-28.

18. The method I use was first described in Patrick Feaster, "New Directions in Phonautographic History," Association for Recorded Sound Collections annual conference, Washington DC, 29 May 2009 (audio available at arsc-audio.org).

19. Scott, *Problème*, 73.

20. Two complementary explanations for the tempo of item 36 have been offered: (1) Scott may have believed longer notes would be easier to study visually, and (2) "Au Clair de la Lune" is traditionally sung slowly as a lullaby, an insight I owe to Marie-Madeleine Mervant-Roux.

21. For a contemporary explanation in English of the distinction between "simple" and "double" vibrations and the confusion it caused, see Charles Knight, *Arts and Sciences or Fourth Division of "The English Cyclopædia"* (London: Bradbury, Evans, & Co., 1867), 3:207.

22. Among the phonautograms Scott exhibited during a presentation to the Cercle de la Presse Scientifique on 23 Nov. 1857 was one of "toute une gamme de cornet à piston" ["a whole scale by a cornet"], which further supports the proposed interpretation; see "Chronique," *L'Ami des Sciences* 1857;3(6 Dec.):770.

23. "Scientific: Phonautograph," *Literary Gazette* (London, England) 1859;n.s.3(15 Oct.):384.

24. "Traces imprimées des sons produits par la voix humaine," *L'Ami des Sciences* 1857;3(19 Apr.):256, cited there as reprinted from "la *Science*."

25. See e.g., F[rançois]-A[chille] Longet, *Traité de physiologie*, 2 vols. (Paris: Masson, 1850 –), 2:[1]:139.

26. See also the keys accompanying items 21 and 22, the former of which is reproduced in Benoit et al., "Chronique," 77; these do not show the superimposed "waves of condensation" but do suggest the type of larger pattern shown in Fig. 3, which appears prominently in each of the phonautograms Scott describes as documenting "waves of inflection."

27. It is also possible that the musical instrument shown being played into the recording funnel of a phonautograph in figure 6 of Scott's 1857 *brevet d'invention* is supposed to be an oboe, though the bell is drawn too large if so.

28. Félix Savart, "Recherches sur les usages de la membrane du tympan, et de l'oreille externe," *Annales de chimie et de physique* 1824;26:5-39. Scott references Savart's theories of audition, both directly and as paraphrased by Longet and Masson, in his "Principes de Phonautographie" (*PM* 6-7).

29. Brock-Nannestad, "Prosody," 2401.

30. "Rapport fait par M. Lissajous," 143.

31. Johann Müller, *Lehrbuch der Physik und Meteorologie,* 2 vols. (Braunschweig: Friedrich Vieweg und Sohn, 1862-63), 1:440, and illustrated graphically in Fig. 514.

32. David Giovannoni, "First Sounds Initiatives," Association for Recorded Sound Collections annual conference, Palo Alto, California, 28 March 2008 (audio available at arsc-audio.org), citing J. A. Zahm, *Sound and Music* (Chicago: A. C. McClurg and Company, 1892), 74. In fact, Koenig himself had reported the figure as 870.9 v.s., to just one decimal place; see Rudolph Koenig, "Untersuchungen über die Schwingungen einer Normalstimmgabel," *Annalen der Physik und Chemie* 1880;n.s.9:394-417.

33. Rudolph Kœnig, "Instruction pour le maniement du Phonautographe," manuscript dated October 1865, Musée de la civilisation, Québec City, p. 1.

34. Scott, *Problème*, 60.

35. A[dolphe] Ganot, *Traité élémentaire de physique expérimentale et appliquée et de meteorologie,* 9th ed. (Paris: chez l'auteur-éditeur, 1860), 209-210. The plate of phonautogram fragments printed in Karl Vierordt, *Grundriss der Physiologie des Menschen* (Frankfurt am Main: Meidinger Sohn & Comp., 1860), 255, may predate Ganot's publication but appears more likely to have been the work of Rudolph Koenig.

36. See e.g., F.-S. Beaudant, *Essai d'un cours élémentaire et général des sciences physiques,* Partie Physique (Paris: Tilliard, Croullebois, Verdière, 1815), 183-184.

37. Scott, *Problème*, 72-3.

38. [Auguste-Toussaint] Scott de Martinville [II], *Histoire de la sténographie depuis les temps anciens jusqu'à nos jours* (Paris: Charles Tondeur, 1849), 147-148. An autobiographical manuscript by Édouard-Léon in the possession of the Scott de Martinville family confirms that this book was written by his father, and not by himself as is often claimed.

39. Luigi Cherubini, *Missa Solemnis Nr. 2 D-Moll* (Frankfurt, New York, London: Henry Litolff's Verlag / C. F. Peters, 1985), 135-146.

40. F. Bernard and Bourget, "Memoir sur les vibrations des membranes élastiques," *Comptes rendus hebdomadaires des séances de l'Académie des sciences* 1860;51:322-325.

41. The signature on the phonautogram matches that of the handwritten dedication on the title page of the Harvard University library copy of A[uguste-Charles] Gérardin, *Rapport sur l'altération, la corruption et l'assainissement des rivières* (Paris: Imprimerie Nationale, 1874).

42. See e.g., Louis Figuier, *Les merveilles de la science,* Supplement (Paris: Jouvet et C^{ie}, [1890?]), 632.

43. Victor Massé, *La reine Topaze, opéra comique en 3 actes* (Paris: Mme. Cendrier, [n.d.]), 63-68.

44. The composition was still unidentified when I first played item 50 in public at the ARSC conference in Washington DC on 29 May 2009. I owe thanks to Peter L. Goodman for his help in the quest to identify it, as well as to David Lasocki of Reference Services at the William & Gayle Cook Music Library at Indiana University.