Rudolf Pfenninger in his laboratory with hand-drawn sound strips, 1932. Source: Pfenninger Archive, Munich.

"Tones from out of Nowhere": Rudolph Pfenninger and the Archaeology of Synthetic Sound

THOMAS Y. LEVIN

4.014 The gramophone record, the musical idea, the written notes, the sound waves, all stand in the same internal representational relationship to one another that obtains between language and the world.

—Ludwig Wittgenstein, *Tractatus logico-philosophicus* (1921)

"All-of-a-tremble": The Birth of Robotic Speech

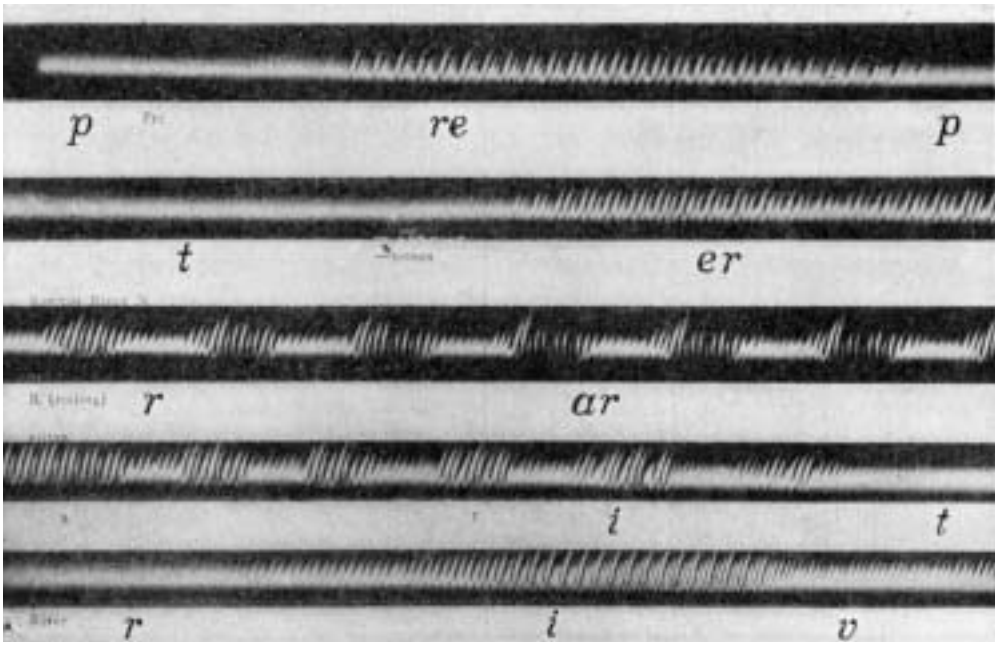
On February 16, 1931, the *New York Times* ran a story on a curious development that had just taken place in England: "Synthetic Speech Demonstrated in London: Engineer Creates Voice which Never Existed" read the headline.[1] The day before, so the article began, "a robot voice spoke for the first time in a darkened room in London . . . uttering words which had never passed human lips." According to the accounts of this event in numerous European papers, a young British physicist named E.A. Humphries was working as a sound engineer for the British International Film Co. when the studio ran into a serious problem. A synchronized sound film (then still quite a novelty) starring Constance Bennett had just been completed in which the name of a rather unsavory criminal character happened to be the same as that of a certain aristocratic British family. This noble clan was either unable or unwilling to countenance the irreducible—even if seemingly paradoxical—polysemy of the proper name (so powerful, perhaps, was the new experience of hearing it actually uttered in the cinema) and threatened a libel suit if "their" name was not excised. As the film had already been shot, however, eliminating it would have involved huge reshooting costs and equally expensive production delays. Consequently, the producers supposedly decided to explore an innovative alternative: unable to get their star back into the studio to simply rerecord and postsynchronize an alternative moniker—the journalistic accounts are uniformly vague as to why—a print of the film was given instead to Humphries, who used his extensive experience as an acoustic engineer to make the necessary changes to the soundtrack *by hand,* substituting in each case an alternative name *in Bennett's "own" voice.*

Top: Manometric flame records of speech by Nichols and Merritt. Published in Dayton Clarence Miller, *The Science of Musical Sounds*, 1934.

Bottom: Phonautograph records. Published in *The Science of Musical Sounds*.

This curious artisanal intervention had become possible because the first widely adopted synchronized sound-on-film system—developed and marketed by the Tri-Ergon and the Tobis-Klangfilm concerns—was an *optical* recording process. Unlike the earlier Vitaphone system that employed a separate, synchronized soundtrack on phonograph discs, the new optical recording technology translated sound waves via the microphone and a photosensitive selenium cell into patterns of light that were captured photochemically as tiny graphic traces on a small strip that ran parallel to the celluloid film images.[2] "In order to create a synthetic voice," so Humphries explains, "I had to analyze the sounds I was required to reproduce one by one from the sound tracks of real voices"; having established which wave patterns belonged to which sounds—that is, the graphic sound signatures of all the required phonetic components—Humphries proceeded to combine them into the desired new sequence and then, using a magnifying glass, painstakingly draw them onto a long cardboard strip. After one hundred hours of work this sequence of graphic sound curves was photographed such that it could function as part of the optical film soundtrack and indeed, when played back on a "talkie" projector, according to the journalist who witnessed the demonstration, "slowly and distinctly, with an impeccable English accent, it spoke: 'All-of-a-tremble,' it said. That was all." But these words—wonderful in their overdetermined thematization of the shiver that their status as *unheimlich* synthetic speech would provoke—were in a sense more than enough: the idea of a *synthetic sound,* of a sonic event whose origin was no longer a sounding instrument or human voice, but a graphic trace, had been conclusively transformed from an elusive theoretical fantasy dating back at least as far as Wolfgang von Kempelen's *Sprachmaschine* of 1791,[3] into what was now a technical reality.

News of the robotic utterance, of the unhuman voice, was reported widely and excitedly in the international press, betraying a nervous fascination whose theoretical stakes would only become intelligible decades later in the post-structuralist discussion of phonocentrism, of the long-standing opposition of the supposed "presence" of the voice as a guarantor of a speaker's meaning with the "fallible" and problematically "absent" status of the subject (and the resulting semantic instability) in writing. Indeed, much like the Derridian recasting of that seeming opposition that reveals writing as the very condition of possibility of speech (and, in turn, of the fullness, stability, and "presence" of the meaning subject), so too does the specter of a synthetic voice, of the technogrammatologics of Humphries's demonstration of a speaking produced not by a human agent but by a process of analysis and synthesis of acoustic data—literally by an act of inscription—profoundly change the very status of voice as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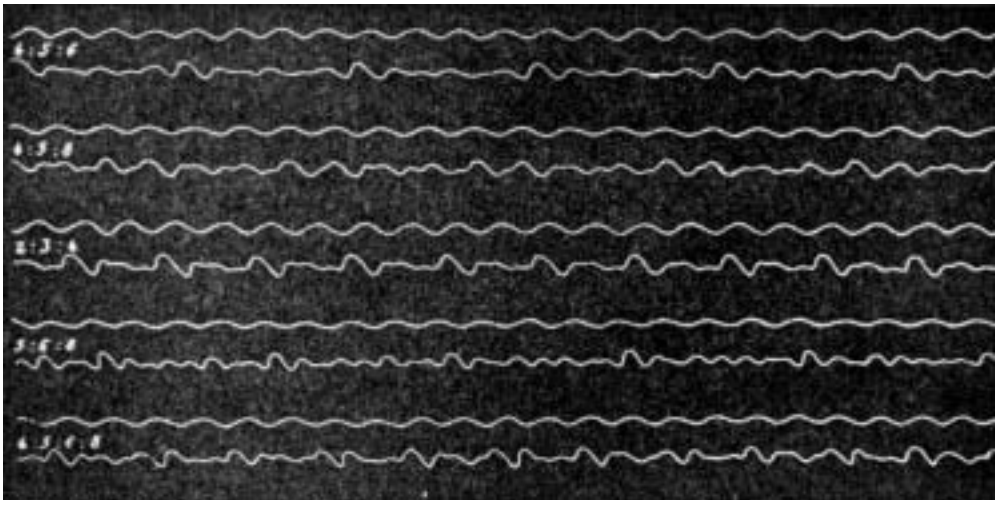
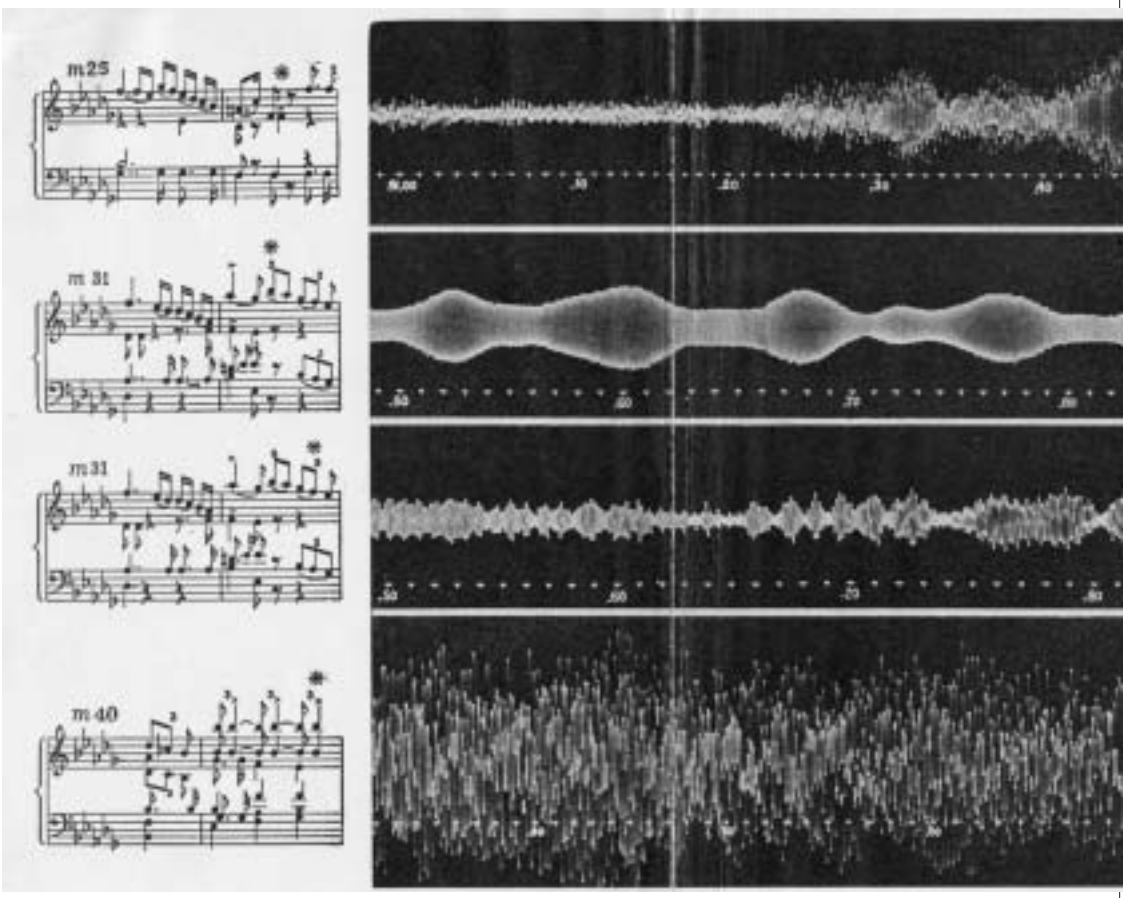
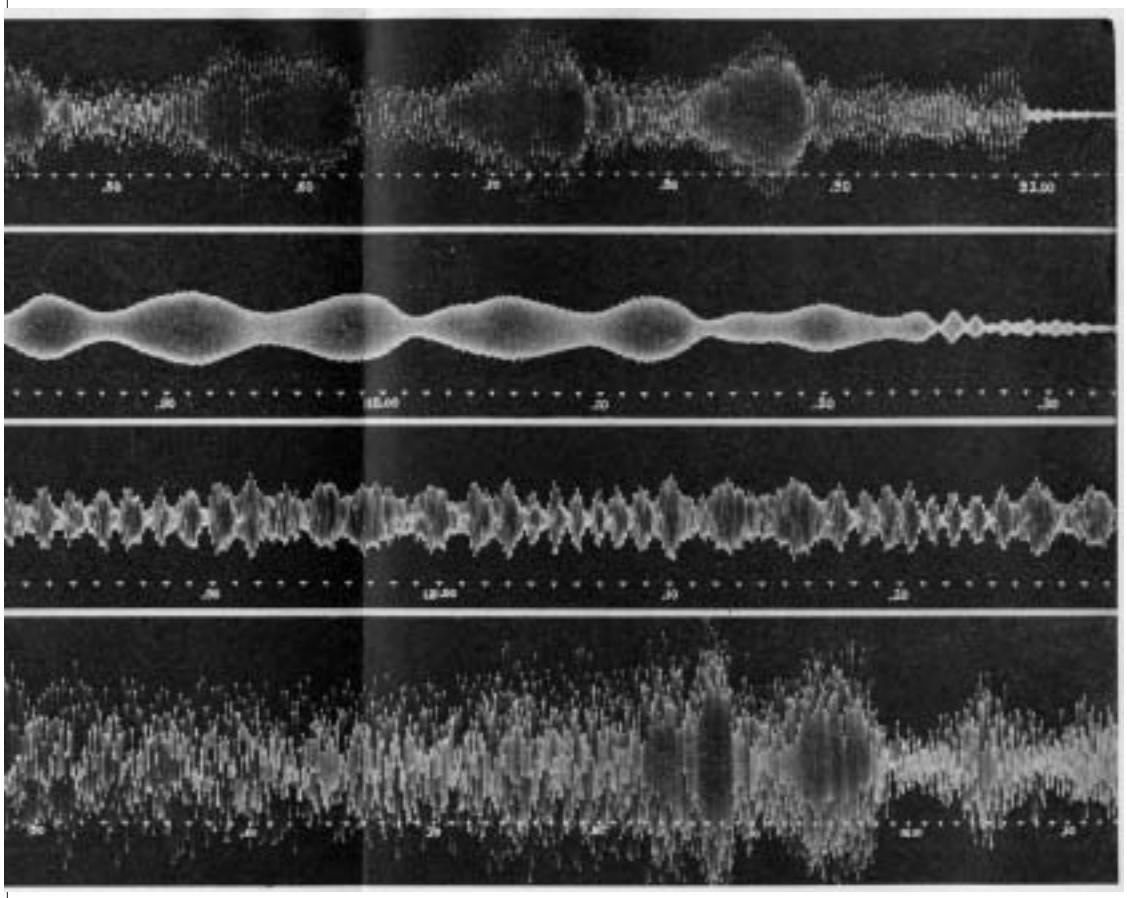


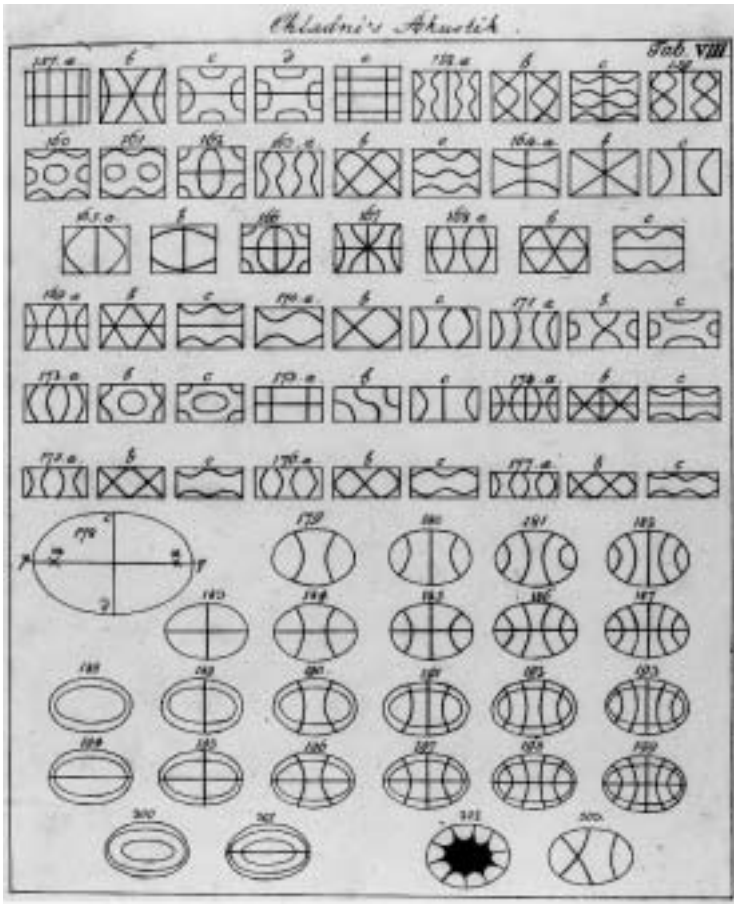


"Photographs of sound waves"—phonograph recording of the vocal sextette from "Lucia di Lammermoor" with orchestral accompaniment. Published in *The Science of Musical Sounds*.



Right: Plate VIII cataloguing different "Tone Figures." From Ernst Florens Friedrich Chladni's *Die Akustik*, 1802.

Opposite: Demonstration of the production of Chladni "tone figures."



such. This proleptic technological articulation of the "linguistic turn," this production of a voice by graphic means, was itself, however, the product of a long-standing project whose most recent chapter had been the invention of the phonograph and gramophone. This writing *(grame)* of sound *(phone)* had already effected a crucial dissociation, effectively making possible, through the recording and subsequent playback of the voice, the separation of speech from the seeming presence of utterance. Once, thanks to the phonograph, one's voice can resound even when one is absent—indeed even after one is dead—then voice is, as Friedrich Kittler put it so aptly, "posthum schon zu Lebzeiten" (posthumous already during [its] lifetime),[4] which is to say already of the order of writing, because to write, as Derrida once put it, is to invoke a techne that will continue to operate even during one's radical absence (i.e., one's death).

Yet while the condition of possibility of the phonographic capturing and rephenomenalization of the acoustic was indeed a kind of acoustic writing, the inscription produced by the gramophonic "pencil of nature" was barely visible, hardly readable as such. In the end, the "invention" of synthetic sound—that is, the ability to actually "write" sound as such—effectively depended on four distinct developments:

1. the initial experiments that correlated sound with graphic traces, making it possible to "see" the acoustic;

2. the invention of an acoustic writing that was not merely a graphic translation of sound but one that could also serve to reproduce it (this was the crucial contribution of the phonograph);

3. the accessibility of such acoustic inscription in a form that could be studied and manipulated *as such;* and finally

4. the systematic analysis of these now manipulatable traces such that they could be used to produce any sound at will.

The archaeology of the above-mentioned robotic speech, in turn, also involves four distinct stages:

1. the coming-into-writing *(mise-en-écriture)* of sound as mere graphic translation or transcription;

2. the functional development of that inscription as means to both trace and then rephenomenalize the inscribed sound;

3. the optical materialization of such sounding graphic traces that would render them available to artisanal interventions; and finally

4. the analytic method that would make possible a functional systematic vocabulary for generating actual sounds from simple graphematic marks (of the sort made famous by Humphries).

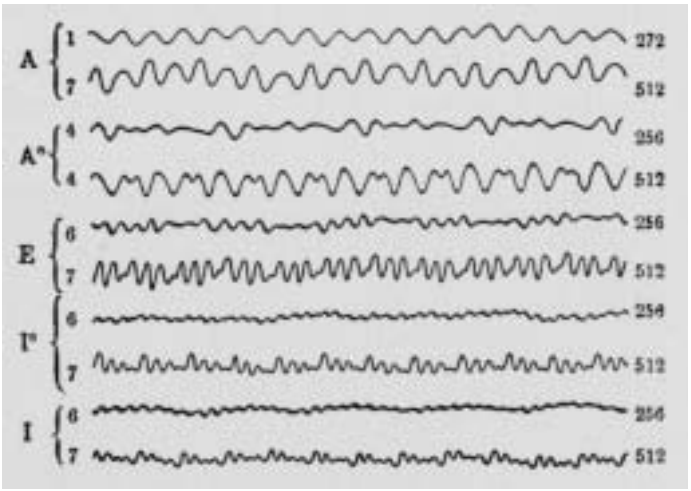
Following a brief overview of these first two, generally more well-known moments, this essay will focus on the latter, largely ignored, chapters of the fascinating story of the "discovery" of synthetic sound.

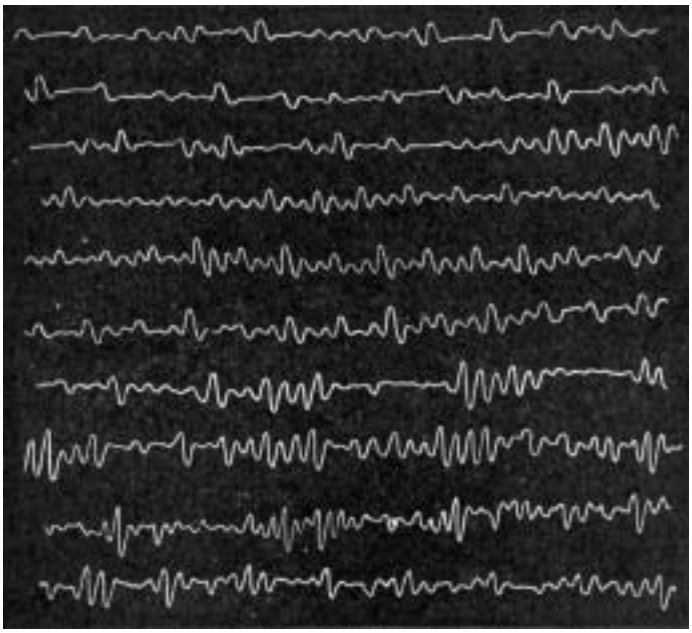
Genealogics of Acoustic Inscription

Already in the 1787 text *Entdeckungen über die Theorie des Klanges* (Discoveries about the Theory of Sound) by the so-called father of acoustics, Ernst Florens Friedrich Chladni, one can read about a graphic transcription of sound that, unlike all previous notational practices, was not strictly arbitrary. Chladni's discovery that a layer of quartz dust upon a sheet of glass would, when vibrated by a violin bow, form distinct and regular patterns or *Klangfiguren* (tone figures), as he called them, that correspond to specific tones, effectively demonstrated the existence of visual traces of pitches whose iconico-indexical character differentiated them in a semiotically crucial fashion from all other conventional means of notating sound. What was so exciting about these acoustic "ur-images" (as a contemporary of Chladni called them) was that they seemed to arise from the sounds themselves, requiring for their intelligibility not the hermeneutics appropriate to all other forms of musical notation but instead something more akin to an acoustic *physics.* The subsequent prehistory of the phonograph—and Chladni's practical insight into the relationship of sound, vibration, and its graphic transcriptionality points to nothing less than the inscriptional condition of possibility of the phonograph as such—is concerned initially with the rendition of sound as (visible) trace. Indeed, this task was of great interest to the nascent field of early linguistics known since the 1830s alternately as *Tonschreibekunst,* phonography, or vibrography, which both supported and profited from various protophonographic inventions.[5] Central among these were Edouard Léon Scott's wonderfully named "phon-autograph" of 1857, often described as the first oscillograph employed for the study of the human voice;

Top: "Vowel curves enlarged from a phonographic record." Published in *The Science of Musical Sounds*.

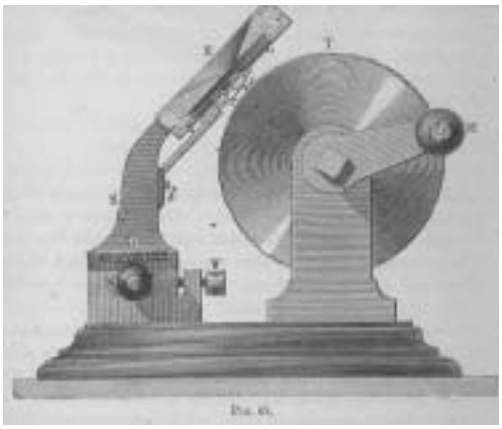
Bottom: "A tracing, by [Edward Wheeler] Scripture, of a record of orchestral music." Published in *The Science of Musical Sounds*.





the Scott-Koenig Phonautograph" of 1859, which (like its predecessor) transcribed sound waves in real time as linear squiggles; and Edward L. Nichols and Ernst George Merritt's photographic records of the flickering of Rudolph Koenig's 1862 manometric capsule, in which changes in pressure produced by sound waves are captured by the vibrations of a burning gas flame. In various ways, all these technologies were exploring the relationship of speech and inscription, as evidenced, for example, in the experiments undertaken in 1874 by the Utrecht physiologist and ophthalmologist Franciscus Cornelius Donders, who is described as having used Scott's phonautograph to record the voice of the British phonetician Henry Sweet, noting next to the acoustic traces the exact letters being spoken, while a tuning fork was used to calibrate the curves.[6]

But if sound in general—and speech in particular—is here rendered visible by various means as graphic traces, this particular sort of readability (with its undeniable analytic value) is bought at the price of a certain sort of functionality: sound is literally made graphic, but in the process becomes *mute.* This changes dramatically in the next stage of this techno-historical narrative. Thomas Alva Edison's invention in 1877 of the first fully functional acoustic read/write apparatus successfully pioneered a new mode of inscription that both recorded *and* re-produced sound, albeit now at the price of the virtual invisibility of the traces involved. What had previously been a visually accessible but nonsounding graphematics of the acoustic was now capable of both tracing and rephenomenalizing sound, but by means of an inscription that—in a gesture of media-historical coquetry—hid the secrets of its semiotic specificity in the recesses of the phonographic grooves. This invisibility not only served to foster the magical aura that surrounded the new "talking machines"—leading some early witnesses



Top: Léon Scott's phonautograph, 1857.

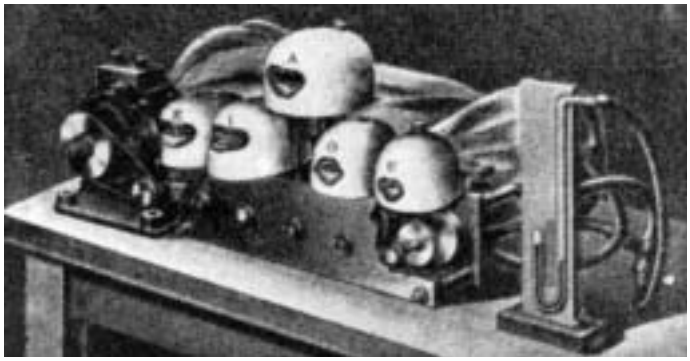
Bottom: Drawing of side view of Edison phonograph, 1877.

of the first demonstration of Edison's new machine at the Paris Academy of Sciences on March 11, 1878, to accuse the inventor's representative du Moncel of ventriloquistic charlatanry[7]—but also raised the question as to the status of the cylindrical traces. It was generally acknowledged that the tiny variations in the spiral groove were a writing of some sort—indeed, as Friedrich Kittler has noted, the reason why it is Edison's cylinder phonograph and not Emil Berliner's flat gramophone record that has been the repeated object of literary fascination is due to no small degree to the fact that the cylinder's "read/write" inscriptional capacity—it is both a playback *and* and recording device—enables it to do what was previously only possible on paper.[8] Nevertheless, contemporaries of Edison's invention were divided as to whether one ought ever "to hope to be able to read the impressions and traces of phonographs, for these traces will vary, not alone with the quality of the voices, but also with the differently related times of starting of the harmonics of these voices, and with the different relative intensities of these harmonics."[9] Others, however, were convinced that, as a later enthusiast put it, "by studying the inscriptions closely one may come to an exact knowledge of these inscriptions and read them as easily as one reads musical notes for sound."[10]

For reasons whose motivations might well have been less than entirely "scientific," Edison's own position was that the gramophonic traces ought *not* be understood as writing. In the context of congressional hearings in 1906 and 1908 on the question of whether recorded sound was copyrightable, Frank L. Dyer, Edison's patent attorney, CEO, and sometime biographer, testified that recordings were not copies of "writings" because they were not legible. To support this claim he recounted how Edison had attempted in vain to make the phonograph records readable through the following laboratory strategy: having made a recording of the letter *a,* "he examined with a microscope each particular indentation and made a drawing of it, so that at the end of two or three days he had what he thought was a picture of the letter 'a.'" But when he compared different recordings of the same letter it became clear that the "two pictures were absolutely dissimilar."[11] This spurious confusion of the status of alphabetical and phonological signifiers (the two recordings of the letter *a* are different because they record both the letter and its *pronunciation*)—which seems suspiciously convenient in this economico-juridical context—does not arise in a similar debate that took place

Right: "Apparatus for imitating the vowels." Published in Dayton Clarence Miller, *The Science of Musical Sounds*, 1934.

Opposite: "Schallplattenschrift 'Nadelton'" (Record writing).



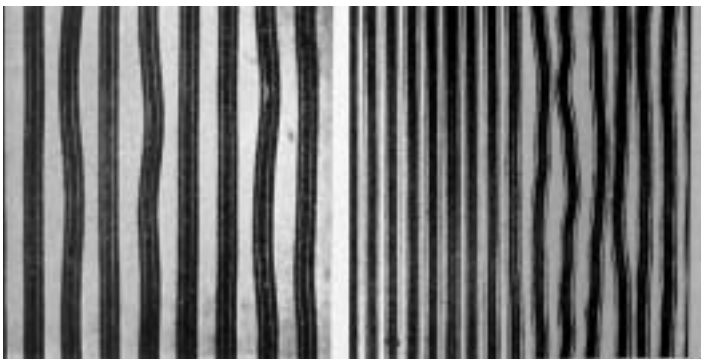
in the German court system the same year, concerning the status of recordings of Polish songs that glorified the independence struggles of the previous century. After a series of earlier decisions pro and contra, the high court decided unambiguously that these gramophonic inscriptions were indeed writing and could thus be prosecuted under paragraph 41 of the criminal code that governs illegal "writings, depictions or representations":

> The question as to whether the impressions on the records and cylinders are to be considered as written signs according to paragraph 41 of the State Legal Code must be answered in the affirmative. The sounds of the human voice are captured by the phonograph in the same fashion as they are by alphabetic writing. Both are an incorporation of the content of thought and it makes no difference that the alphabetic writing conveys this content by means of the eye while the phonograph conveys it by means of the ear since the system of writing for the blind, which conveys the content by means of touch, is a form of writing in the sense of paragraph 41.[12]

Given that the definition of writing invoked in this decision is strictly a functional one (phonographic traces are writing because they function as a medium that stores and transmits language), what remains unexamined here is the specificity of these almost invisible scribbles *as inscriptions.* Like most end users, the court was more concerned with what the speaking machines produced, but not how they did so. This latter question did however become an issue, although in an entirely different field of research—phonetics—whose foundational text is Alexander Melville Bell's 1867 opus entitled, appropriately, *Visible Speech.*[13]

From "Groove-Script" to "Opto-Acoustic Notation"

Provoked, one is tempted to say, by the script-like quality of the now actually sounding phonographic inscriptions and their migration into the invisibility of the groove, phonologists and phoneticists of various stripes—pursuing the elusive Rosetta Stone of phonographic hieroglyphics—attempted in various ways to make these functional acoustic traces visible.[14] Above and beyond their particular scientific motivation, each of these experiments also implicitly raised the question of the legibility of the semiotic logic of the gramophonic traces. Indeed, the continuing fascination with this possibility might well account for the sensation caused as late as 1981 by a certain Arthur B. Lintgen, who was able—repeatedly and reliably—to "read" unlabeled gramophone records, identifying not only the pieces "contained" in the vinyl but also sometimes even the conductor or the nationality of the orchestra of that particular recording, merely by looking at the patterns of the grooves. It matters little what the "man who sees

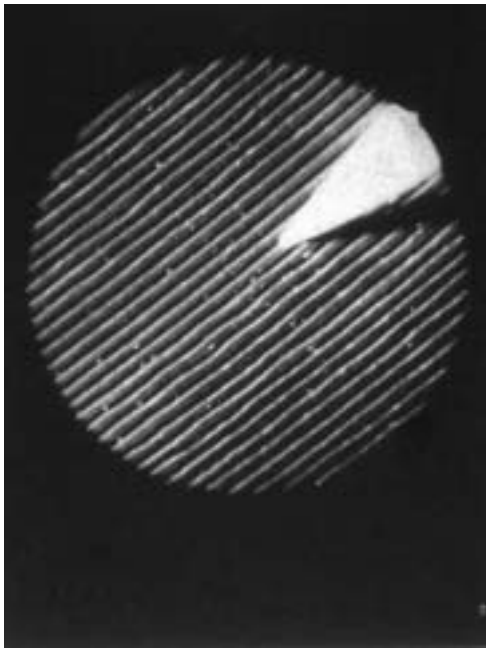


what others hear" (as he is called in the headline of the lengthy *New York Times* account of his unusual ability[15]) was *actually* doing what he claimed: in either case his performance and its widespread reception (as evidenced, for example, by his subsequent appearance on the ABC television program *That's Incredible*) are both significant as cultural allegory, as a *mise-en-scène* of the at least *potential* readability of the still indexical gramophonic trace at the very moment that the material inscription of sound—with the advent of the compact disc and its hallmark digital encoding in the early 1980s—was becoming phenomenally even more elusive. Lintgen's *Trauerspiel* of acoustic indexicality, quite possibly the last manifestation of the long and anecdotally rich history of the readability of acoustic inscription, also confirms that not only the prehistory but also the posthistory of the phonograph can reveal what remains hidden in the depths of gramophonic grooves.[16]

Implicit in the drive to read the gramophonic traces is the notion that, once decipherable, this code could also be employed for *writing.* While the impulse to both *read and write* sound was, according to Douglas Kahn, "a desire, already quite common among technologists in the 1880s,"[17] the fascination exerted by the sheer phenomenal wonder of recorded sound (and all its equally astonishing technical consequences, such as acoustic reversibility and pitch manipulation) was—understandably—so great that for the first fifty years following the invention of the phonograph it effectively distracted attention from the various practical and theoretical questions raised by the gramophonic traces themselves, even when these were acknowledged as such. Typical in this regard is the simultaneous blindness and insight regarding gramophonic inscription in the following highly suggestive passage from Ludwig Wittgenstein's *Tractatus logico-philosophicus* of 1921:

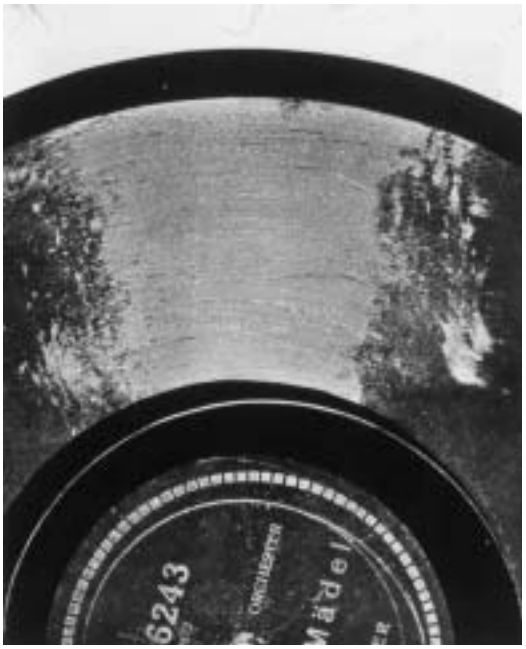
> 4.0141 There is a general rule according to which the musician can extrapolate the symphony from the score, and according to which one can derive the symphony from the groove on the gramophone record and then, using the first rule, in turn derive the score once again. That is what constitutes the inner similarity between these seemingly so completely different constructs. And this rule is the law of projection, which projects the symphony into the language of musical notation. It is the rule for the translation of the language of musical notation into the language of the gramophone record.[18]

While Wittgenstein invokes both the gramophonic trace and "the language of the gramophone record," and in the final line even effectively juxtaposes gramophonic "language" with another form of musical notation, a careful reading of



the passage reveals that Wittgenstein's concern is not the character of the gramophone record's inscriptions as such but rather the technical capacity of that "language" to store and re-produce sound. Dramatically different, by comparison, and an index of an important shift in the sensibility toward the *semiotic specificity* of the gramophonic grooves as such, is the intriguing remark in Rainer Maria Rilke's famous prose piece "Ur-Geräusch" (Primal Sound), written only two years earlier, in which the young poet describes his early fascination with the new acoustic technology: "As time would tell it was not the sound from the horn that dominated my recollection, but instead it was those curious signs etched into the cylinder that remained much more significant to me."[19] Unlike Wittgenstein, for whom the gramophone is significant thanks to its capacity to re-produce a given piece of music, Rilke's concern is with the "ur-sound" that might arise from a gramophonic tracing of the cranial groove in a skull sitting on his table. This thought experiment raises the question of the gramophone's capacity to render audible sounds that were never previously recorded, or, in Kittler's apt terminological recasting, to decode an inscription that had never been previously encoded.[20] While the appeal of this seminal techno-semiotic allegory lies precisely in the nonetheless still referential fascination that informs Rilke's musings on the skull's groove as the locus of some sort of a *signal* (i.e., an inscription that, while not produced by a subject, might nevertheless be a trace of some other signifying agency), the sound that this hypothetical phonography of the cephalic suture would in fact produce would most probably resemble what we tend to call noise and as such would "refer" acoustically more to the materiality of technical mediation as such—that is, to the literal topography of the sonic groove.[21]

The stakes involved in the difference between Wittgenstein's focus on the *result* of gramophonic inscription and Rilke's insistence on the epistemological questions raised by the physical mediation *as such*, are given what is probably their most programmatic articulation in the famous essay by the pioneering avant-garde polymath László Moholy-Nagy entitled "Production-Reproduction," which appeared in 1922 in the journal *De Stijl*.[22] In this classic text of Weimar-era gramophonic modernism, Moholy-Nagy argues that because art serves the function of training man's sensory and other apparatuses for the reception of the new, then creative activities that hope to do justice to the imperatives of their time must explore the unknown rather than simply re-produce the familiar. Applied to the acoustic domain, this means that the gramophone must be trans-



Opposite: Close-up photograph of a phonograph record showing the point of the needle and the "wavy" grooves. Area shown is a ⅓" in diameter.

Right: Lásló Moholy-Nagy. *Gramofonplatte* (gramophone record). Published in *Malerei Fotografie Film* (1925).

formed from a mere means of *re*-production (i.e., a medium that simply records, stores, and then rephenomenalizes sounds created elsewhere) into a tool of *pro*duction, an instrument in its own right; that is, a technology that will produce new, previously unheard sounds specific to its capacities. In doing so, it would realize a potential also promised (but also not always realized) by other new mechanical musical devices—such as the Trautonium, Sphaerophon, and the Atherophon or Theremin—which were all the rage in the Western musical world of the 1920s. Manifesting a focus more reminiscent of Rilke than Wittgenstein, Moholy-Nagy proposes that one undertake a scientific examination of the tiny inscriptions in the grooves of the phonograph in order to learn exactly what graphic forms corresponded to which acoustic phenomena. Through magnification, he suggests, one could discover the general formal logic that governed the relation of the acoustic to the graphematic, master it, and then be able to produce marks that, once reduced to the appropriate size and inscribed onto the record surface, would literally be acoustic writing:

> the grooves are incised by human agency into the wax plate, without any external mechanical means, which then produce sound effects that would signify—without new instruments and without an orchestra—a fundamental innovation in sound production (of new, hitherto unknown sounds and tonal relations) both in composition and in musical performance.
>
> The primary condition for such work is laboratory experiments: precise examination of the kind of grooves (as regards length, width, depth, etc.) brought about by the different sounds; examination of the man-made grooves; and finally mechanical-technical experiments for perfecting the groove-manuscript score. (Or perhaps the mechanical reduction of large groove-script records.)

Liberating the gramophone from the mere "photographic" re-production of prior sounds, this "groove-script alphabet"—as Moholy-Nagy called it a year later in an essay entitled "New Form in Music: Potentialities of the Phonograph"—would make the gramophone into "an overall instrument . . . which supersedes all instruments used so far," allowing one to employ the technology as a means to write sound directly, enabling composers to eliminate the intermediary of the performance by "writing" their compositions as sounding scripts, and making it possible for sound artists to express and transmit any language or sound, including previously unheard acoustic forms and works.[23]

In the mid-1920s Moholy-Nagy's challenge was taken up and further articulated by the music critic Hans Heinz Stuckenschmidt in a series of polemical interventions in numerous journals ranging from *Der Auftakt* to *Modern Music.* Enlisting the gramophone in the project of a musical *Neue Sachlichkeit* (New Objectivity), Stuckenschmidt mobilized Moholy-Nagy's arguments (both implicitly and explicitly) for debates in musical composition, interpretation, and performance, including the highly provocative claim that by means of works written specifically for the new technologies, the composer could eliminate the subjective dimensions invariably introduced both through the irreducibly ambiguous character of musical notation and the vicissitudes of "live" performance. Insisting that, thanks to machines such as the gramophone, "the role of the interpretor is a thing of the past,"[24] Stuckenschmidt's philo-gramophonic articles elicited vicious and often Luddite responses. Happily, however, there was also another dimension to the reception of his polemics—one that responded to his important claim that "the essential significance of these machines [phonographs and gramophones] lies in the possibility of writing for them in an authentic fashion."[25] Continuing what was by then almost a tradition of pieces composed expressly for new acoustic technologies—such as Ferruccio Busoni's 1908 sketch "Für die [sic] Pianola" or Igor Stravinsky's "Etude pour Pianola" of 1917 (whose 1921 premiere in London took place in the player piano company's own "Aeolian Hall")—the 1920s had witnessed a proliferation of works written for "musical machines" (as they were called at the time). These experiments were most often premiered at new music festivals such as the Donaueschingen Musiktage whose 1926 program featured works for Welte-Mignon pianola rolls composed by Paul Hindemith, Ernst Toch, and Gerhart Münch. Although Stuckenschmidt claimed as early as 1925 that "I myself carried out fundamental experiments with the gramophone at the same time that George Antheil was doing so in Paris,"[26] the earliest documented public performance of gramophone-specific music was not until 1930 at the Musikfest Neue Musik held at the Staatliche Hochschule für Musik in Berlin, where Ernst Toch presented a gramophonic montage of his four-part "Fuge aus der Geographie" and Paul Hindemith premiered his oft-invoked but only recently rediscovered experiments in "grammophonplatten-eigene Stücke" (pieces specifically for gramophone records).[27]

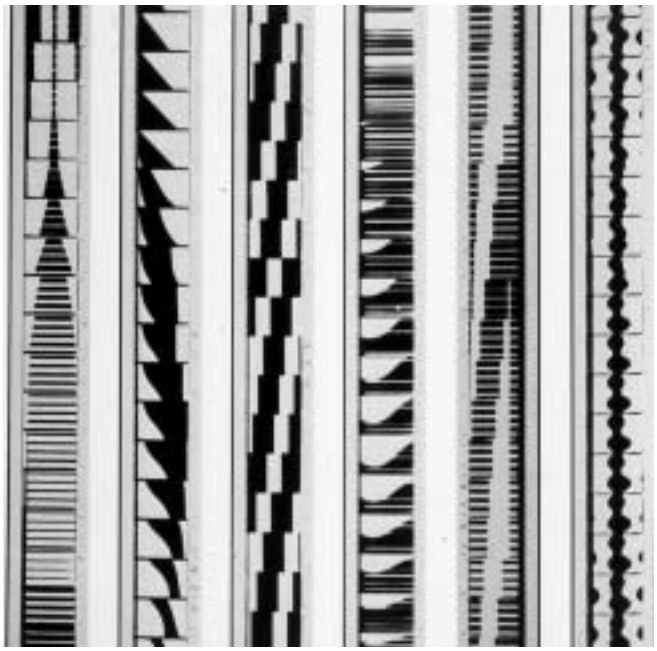
While one cannot ignore the very real possibility that various gramophone-specific sound experiments, of which there are few or no remaining traces, might have been undertaken in marginal venues, laboratories, and nonperformance contexts in the later 1920s, the extended interval between Stuckenschmidt's 1925 rearticulation of Moholy's 1922 proposal and the known instances of its

subsequent realization might nevertheless be quite telling. In fact, it matters little whether Hindemith and Toch's 1930 gramophonic compositions were, as a contemporary critic called them, the very first of their kind.[28] What is significant is that while both explored the new sonic possibilities offered by the overlapping of multiple recordings and "live" music, as well as the variations in speed, pitch and timbre that could be achieved only by the creative "misuse" of the gramophone, neither of their compositions nor any of the other "gramophonic" works of that period, to my knowledge, actually intervened at the level of the "groove-script alphabet." Despite published journalistic accounts describing early groove-script experiments by Moholy-Nagy and Antheil,[29] Moholy-Nagy himself confirms that although he had been able to get both Stuckenschmidt and Antheil interested in exploring this possibility in the mid-1920s and although the director of the Vox Corporation, a certain Jatho, had agreed to allow them to use their laboratories, "in the end my suggestions were never fully worked out in detail."[30] According to Moholy-Nagy, this was due to various institutional circumstances: Antheil, he explains, moved to Paris where he worked on player pianos for Pleyel, and Moholy himself had to devote his attentions to his new job at the Weimar Bauhaus. The reasons might also have been more technical in nature, as suggested by Hindemith's own rather skeptical remarks on the pragmatics of groove-script composing published only a few years prior to his proto-turntablist appearance in Berlin:

> The attempts to manually etch musical events onto gramophone or phonograph records have so far remained unsuccessful. At present we have come so far as to be able to depict very simple relations such as specific vowels in conjunction with specific pitches. But it is a very long way from here to the generation of even plain musical works. I don't think that it will ever be possible to make this mode of inscription useful for musical practice.[31]

As it turns out, Hindemith was both right and wrong: as he predicted, the gramophone would *never* prove amenable to the realization of a proper groove-script alphabet; yet, contrary to his prognosis, something very akin to the possibility envisioned by Moholy-Nagy was in fact being worked out at almost exactly the same time as the Hindemith-Toch experiments, albeit in a somewhat different medium—the synchronized sound film.

Always the pragmatist, Moholy-Nagy immediately recognized in the new *optical* film sound processes being adopted in the late 1920s a means to effectively realize his long-standing groove-script vision. Here the technical difficulties posed by the miniature scale of the groove-script inscriptions were eliminated by a graphic transcription of sound that was visible to the human



Right: Oskar Fischinger. Hand-drawn ornamental sound tracks, 1932–33.

Opposite, top: 1932 Emelka publicity photograph with the caption, "This is what Rudolf Pfenninger's 'Sounding Handwriting' looks like."

Opposite, bottom: Juxtaposition of various competing optical sound systems. From left to right; the Tobis System, the American system, and two versions of the Tri-Ergon system used by Pfenninger.

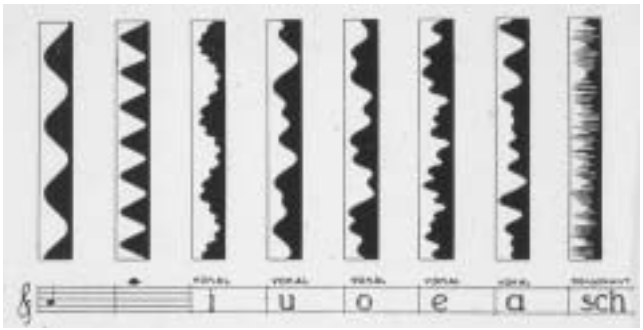
eye. In an essay entitled "Problems of the Modern Film" published in various versions and languages between 1928 and 1932, Moholy-Nagy laid down his gauntlet in typically polemical fashion, challenging filmmakers to take up the task that had so far generally eluded (or been ignored by) composers:

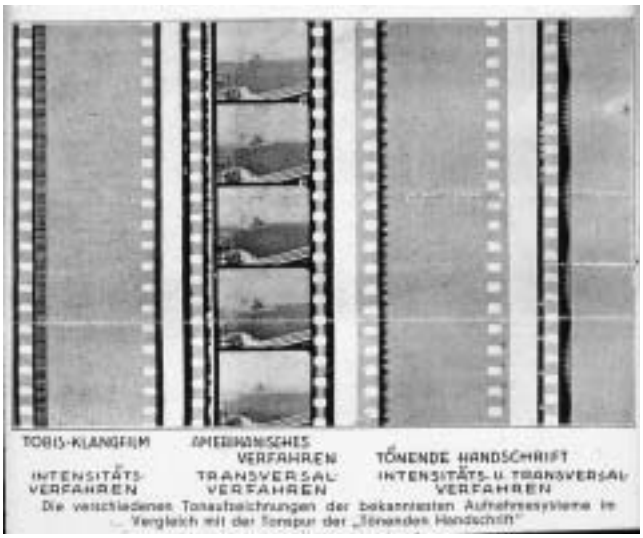
> Contemporary "musicians" have so far not even attempted to develop the potential resources of the gramophone record, not to mention the wireless or ether-waves. . . . The sound film ought to enrich the sphere of our aural experience by giving us entirely unknown sound values, just as the silent film has already begun to enrich our vision.[32]

Calling for a "a true opto-acoustic synthesis in the sound film" Moholy-Nagy predicted the emergence of the "abstract sound film" (which would be complemented by the parallel genres of the "documentary" and the "montage" sound film) and suggested that experimentation be undertaken with the soundtrack *in isolation from the image track.* That is, Moholy-Nagy recognized optical film-sound technology as an important innovation *in sound recording as such,* not least because this new form of acoustic inscription seemed to make possible what had always been so frustratingly elusive in the gramophonic realm: access to sound as trace. Besides investigations of "acoustic realism" (i.e., recorded extant sounds), he insisted on the importance of

> experiments in the use of sound units which are not produced by any extraneous agency, but are traced directly on to the sound track and then translated into actual sound in the process of projection. (E.g., the tri-ergon system uses parallel lines of a varying brightness, the alphabet of which must be previously mastered.) . . . It will not be possible to develop the creative possibilities of the talking film to the full until the acoustic alphabet of sound writing will have been mastered. Or, in other words, until we can write acoustic sequences on the sound track without having to record any real sound. Once this is achieved the sound-film composer will be able to create music from a counterpoint of unheard or even nonexistent sound values, merely by means of opto-acoustic notation.[33]

Moholy's unambiguous recognition that the new optical sound techniques presented an alternative means to achieve in practice what he had initially





conceived in terms of the groove script alphabet also might explain why, by the later 1920s, he was no longer pursuing his original gramophonic approach: film simply seemed to offer a better way to explore more or less the same issues.

As it turns out, Moholy-Nagy did not have to wait long for this challenge to be taken up and met successfully. Indeed, in an illustrated lecture "on the invention which signifies the revolutionizing of the sound film in its entirety" that he presented in various schools and lecture halls in Germany in 1932, Moholy-Nagy announced, with unambiguous excitement, that his earlier notion of the groove-script—now called "sound-script"—had already become a reality. Revisiting the history of his own writings on the possibilities of synthetic sound from the happy perspective of the visionary whose long-doubted speculations had at long last been proven right, Moholy-Nagy writes (in the published version of that lecture):

> Sound-script makes possible acoustic phenomena which conjure up out of nothing audible music without the previous play of any musical instrument. We are in a position today to be able to play written sounds, music written by hand, without involving an orchestra, by the use of the apparatus of the sound film. It is a great pleasure for me to be able to report on this acoustical phenomenon; inasmuch as I had already explained it in articles and lectures ten years ago, although I was not fortunate enough to be able to experiment with it then, I am very happy today to witness the successful realization of those of my suggestions previously labeled absurd. At the time, my starting point was that phonograph recordings could be made on the basis of an "etched alphabet." These recordings, without any sound having previously been played and captured by them, are inscribed exclusively on the basis of the imaginative world of the composer and would have been played only subsequently. A few years later I extended my phonograph experiments to include radio, sound film and television [*sic*]. *And today, thanks to the excellent work of Rudolph Pfenninger, these ideas have been successfully applied to the medium of*

Oskar Fischinger with rolls of hand-drawn sound, 1932–33. Source: Iota Foundation Archive, Los Angeles.

sound film. In Pfenninger's sound-script, the theoretical prerequisites and the practical processes achieved perfection.[34]

According to a contemporary review of the version of this lecture presented to a gathering of the *Bund das neue Frankfurt* in the Frankfurt Gloria-Palast on December 4, 1932,[35] Moholy-Nagy showed two films in conjunction with his talk: *Tönende Ornamente* by the German pioneer of abstract animation Oskar Fischinger, and *Tönende Handschrift* (Sounding Handwriting) by a comparatively unknown Swiss-born engineer working in Munich named Rudolph Pfenninger. Given the inclusion of Fischinger in this program, and in light of the fact that his much publicized work on what he called "sounding ornaments" has led more than one film historian to credit him (implicitly or explicitly) with the invention of animated sound, why is it that Moholy-Nagy seems to insist—in an assessment later confirmed by nearly all of the historical literature—that the sole credit for the development of a functional sound script—which is to say, the invention of synthetic sound as such—belongs not to Fischinger, but to Pfenninger?[36]

The Race That Wasn't One: Fischinger, Pfenninger, and the "Discovery" of Synthetic Sound

In a classic instance of the curious simultaneity that is the repeated hallmark of the overdetermination governing the history of invention, during the early 1930s a number of people in various parts of the world were working furiously but independently on experiments in what they referred to variously as "hand-drawn," "animated," "ornamental," and/or "synthetic" sound. Besides the aforementioned Humphries in England, in the Soviet Union there were, according to some accounts, no less than three separate groups of researchers working on hand-drawn sound in Leningrad and Moscow: their ranks included figures such as the composer, music theorist, and performance instigator Arsenii Avraamov; the painter, book illustrator, and animator Mikhail Tsekhanovskii; the engineer Evgenii Sholpo; the animators Nikolai Voinov and Nikolai Zhilinski; and the inventor Boris Yankovskii. While space considerations preclude anything more than a cursory treatment of these crucial Soviet contributions here, it should be noted that these groups produced some extremely important theoretical and practical results, not least being the development of a protosynthesizer called the "Variofon" and another known as the "Vibro-Eksponator."[37] At exactly the same time, and as far as I can tell without any knowledge of what was being done in the Soviet Union, similar efforts were also being undertaken in Germany by Pfenninger in Munich and, somewhat later, by Fischinger in Berlin.

Fischinger's widely discussed experiments and lectures during the years 1932–1933 grew out of his extensive earlier work in nonobjective, abstract, or, as he preferred to call it, "absolute" film, which explored the musicality of moving graphic form in the tradition of animated cinematic synesthesia established by the filmmakers Viking Eggling, Hans Richter, and Walther Ruttmann.[38] The first concrete result of these explorations in the relations between musical and graphic elements in time (which the contemporary critic Bernhard Diebold referred to with the charming neologism "Muso-Graphik"[39]) was Fischinger's compilation *Experimente mit synthetischem Ton* (Synthetic sound experiments), which was composed of "patterns, drawn on paper with pen and ink and photographed directly onto the margin of the film reserved for the sound track."[40] Fischinger's practice of making drawings on paper that would then be photographed onto the optical film sound track supposedly was inspired by his experience of hearing a key drop; struck by the fact that he recognized what he heard *as the sound of a key,* Fischinger wondered whether every shape had a corresponding sound, a sort of iconic acoustic signature.

According to William Moritz, this led Fischinger to undertake not only a series of experiments that examined the relationship between visual forms and their corresponding sonic manifestations, but also various attempts at

> drawing designs and ornaments which produced "a-musical" sounds; he found, for example, that the pattern of concentric wave-circles which was often used in cartoon and silent film iconography to represent the ringing of a door or alarm bell actually produced a buzzing clang sound when drawn in long rows and photographed onto the soundtrack area.[41]

Intrigued by the potentially far-ranging ramifications of such acoustico-visual isomorphism, Fischinger often speculated as to whether there was more

than an accidental relationship between the physical shape of an object and its auditory manifestation. Might there exist some deep and previously inaccessible common structural logic that governs both the most prevalent ornamental practices of a given society and its dominant auditory patterns? Posing the question in rather explicitly nationalistic terms in a widely published 1932 essay, Fischinger states:

> Personal, national and characteristic traits naturally will also be expressed in the ornament. In terms of their vocal intonation Germans tend to make a strong attack which corresponds to a specifically jagged curve whereas the soft vocal attack of the French also manifests itself in a correspondingly different fashion in the ornament. There is thus an equally clear "mouth-writing" as there is "hand-writing."[42]

These and other related questions were the focus of investigations that Fischinger presented to great public acclaim in a lecture on synthetic sound at the Haus der Ingenieure in Berlin in the first week of August 1932.[43]

Long before the appearance of Fischinger's well-publicized explorations into the aesthetics of "tönende Ornamente," a little-known animation filmmaker and engineer named Rudolf Emil Pfenninger (1899–1976) had been busily at work in the Geiselgasteig studios of the Münchener Lichtspielkunst AG (EMELKA) perfecting what would turn out to be the first fully functioning and fully documented (i.e., not apocryphal) *systematic* technique for the entirely synthetic generation of sounds. Born in Munich as the son of the Swiss artist Emil (Rudolf) Pfenninger (1869–1936), Rudolf began studying drawing with his father, and then, after initial experiments with a self-made camera and an apprenticeship as set painter in the Munich Werkstätten für Bühnenkunst Hummelsheim und Romeo in 1914, worked together with Emil Pfenninger as illustrator for Gustav Hegi's multivolume reference work on the flora of central Europe.[44] It was during this period that Pfenninger had his first contact with the movies as a projectionist at various Munich cinemas, an experience that required him to become thoroughly familiar with a wide range of film technologies (optics, mechanics, electronics). In 1921 he was discovered in Munich by the U.S. animator Louis

Producing on rolls of hand-drawn sound in the Oskar Fischinger workshop. 1932—in the upper-left corner Hans and Eltriede Fischinger. Source: Iota Foundation Archive, Los Angeles.

Seel, who hired Pfenninger to draw, paint, and make animated films and text frames for silent films for the Münchener Bilderbogen. This was followed in 1925 by a new job in the Kulturfilmabteilung of the EMELKA (after UFA the second-largest film production company of the Weimar era), where he worked on films such as *Zwischen Mars und Erde* (Dir. F. Möhl, 1925). Pfenninger simultaneously pursued intensive engineering research on new radio technologies, in the course of which he developed and patented a number of improvements for loudspeakers, microphones, and so on. It was in the context of this laboratory work that he began his experiments in synthetic sound.

As with Fischinger, there is also an ur-legend surrounding the origin of what Pfenninger called his *tönende Handschrift* (Sounding Handwriting). Unlike Fischinger, however, Pfenninger seems to have been motivated less by synesthesial speculations than by economic necessity. According to the story, the poorly paid inventor Pfenninger was eager to provide a sound track for the experimental animations he was making on the side, but he could afford neither the musicians nor the studio to record them.[45] Instead, he sat down with an oscilloscope and studied the visual patterns produced by specific sounds until he was able—sometime in late 1929 or early 1930[46]—to isolate a unique graphic signature for each tone. Using the newly available optical film soundtrack to test his experimental results, he would painstakingly draw the desired curve onto a strip of paper which he then photographed in order to integrate it into the optical sound track. The resulting sound, phenomenalized by the selenium cell, was one that had never been previously recorded but was, in effect, written by hand: "hand-drawn sound," as Pfenninger called it. And indeed, the first films that Pfenninger made for EMELKA in late 1930 with an entirely synthetic sound track—an extremely labor-intensive task that involved choosing and then photographing the right paper strip of sound curves for each note—were his own undersea animation, *Pitsch und Patsch,* and a "groteskes Ballett" film directed by Heinrich Köhler and entitled *Kleine Rebellion*.

When the discovery of the "Tönende Handschrift" was first presented to journalists in a special demonstration at the Kulturlfilmabteilung of the EMELKA studios in the late spring of 1931, the numerous published accounts compared Pfenninger's breakthrough not with work by Fischinger but, instead, with the recent news of the comparable technical achievement in England by the engineer Humphries. Odo S. Matz, for example, who claims to have been one of the first to hear the results of Pfenninger's new technique, once again opens up the question of historical priority (here laced with an added dimension of national chauvinism) when he points out in his report that Pfenninger was working on his project *before* the news of Humphries's work splashed across newspapers

1932 Emelka publicity photograph with the caption "Rudolf Pfenninger draws a sound strip."

around the world. As if this was not enough, however, Matz goes on to dismiss the achievement of the British competitor as facile techno-mimesis (why bother synthesizing the human voice when any microphone could do it better?), while the "true" pioneer Pfenninger was exploring the much more uncharted aesthetic territory of previously unheard *new* sounds: "Pfenninger, by contrast, uses similar means in order to create new sonic effects which are unknown to our ears because they cannot be generated by any instrument. Herein lies the magical quality of this invention."[47] Indeed, it may well have been the news of Pfenninger's discovery that led Fischinger to suddenly begin to explore a generative rather than simply analogic logic between graphic form and musical sounds: how else to account for the fact that, as Moritz reports," he interrupted his work on his other projects including *Studie Nr.11* in order to produce hundreds of test images which he then recorded as images for the soundtrack."[48]

Having tantalized the public through the press accounts in 1931, very possibly so as not to be eclipsed by the stories about Humphries, EMELKA then waited over a year before announcing the first full-scale public demonstrations of Pfenninger's pioneering achievement in a multicity gala launching of a series of films with entirely synthetic sound tracks. *Die tönende Handschrift: Eine Serie gezeichneter Tonfilme eingeleitet durch ein Film-Interview* (Sounding Handwriting: A Series of Hand-Drawn Sound Films introduced by a Filmed Interview) premiered at the Munich Kammerlichtspiele on October 19, 1932, and the following day at an invitation-only matinee in the grand Marmorhaus cinema-palace in Berlin, an event also attended by Pfenninger, who personally thanked the audience for, as the *Film-Kurier* described it, "its justifiably amazed and enthusiastic response to the screening."[49] The program—which EMELKA circulated to cinemas throughout Europe in late 1932 under the title *Die tönende Handschrift*[50]—consisted of *Kleine Rebellion* and *Pitsch und Patsch,* two "groteske Puppenfilme" by the brothers Diehl entitled *Barcarole* and *Serenade,* and a "Naturfilm" entitled *Largo.* These were preceded by a fascinating pedagogical documentary entitled *Das Wunder des gezeichneten Tones* (The Wonder of Hand-Drawn Sound) (which was also released as a newsreel announcing the new discovery) and consisting of an illustrated history of sound recording followed by an on-camera interview of Pfenninger by the charismatic film personality Helmuth Renar. The journalistic response was, as one might expect, both extensive and largely enthusiastic.[51] Although generally fascinated by the technical achievement and its promise, most critics were perplexed and even annoyed by the new sounds: while some were entranced by what they felt was "very beautiful 'mechanical' music, a sort of carousel music," others wrote of its "primitive and somewhat nasal timbre," how it gave an "impression of being mechanical, almost soul-less,"

and that it had "a snore-like quality and (since the tones belong primarly to the realm of the flutes and plucking instruments), a monotone quality as well."[52] As one reviewer put it, "the sound reminds one of stopped organ pipes, muted horns, harps, xylophones. It sounds strangly unreal."[53]

In lieu of a more detailed account of the fascinating reception history, which will be undertaken elsewhere, consider the following representative account by R. Prévot published the day after the premiere in the *Münchener Neueste Nachrichten:*

> What we saw yesterday morning was more than simply initial experiments. Our technological sense was fascinated, our imagination of the future provoked! . . . At the same time, I must admit that our music-loving ear did go on strike, and our lively artistic consciousness was troubled.
>
> Was this still music? . . . rarely have we felt so clearly the inner difference between live art and technological construct. One heard piano and xylophone-like sounds, others which seemed to come out of a steam whistle–all of them crafted together with great precision, much as if someone were to build a tree out of a thousand pieces of wood, which can look deceptively real and yet will never bloom! . . . Without a doubt, this abstract, this skeletal music fit best with the animated images–here there was a sort of technical unison. But the attempt to "give life" by such musical means to the dance and mimicry of live people seemed utterly impossible. The effect was like that of a dance of the dead! Here we must give voice to a decided "halt!"
>
> . . . Film has finally succeeded in creating a new "technological art" which has its own essence distinct from that of live theater. Perhaps the Pfenninger method will also succeed in finding tones and tonal complexes which are new and cannot be produced by natural means; i.e., a music which does not yet exist—a real music of the future? Let us hope that it turns out to be beautiful![54]

Prévot's response is typical in its combination of techno-fetishistic fascination, its concern with the question of aesthetically "appropriate" sound-image combinations, and above all in the way it registers the instinctive threat to a long-standing, supposedly a-technological conception of music. Many critics insisted that Pfenninger's invention ought to be measured against other new electronic musical instruments or technologies of the time, such as the Theremin or the Trautonium, in that, like them, its future lay in the exploitation of its capacity to make "new" sounds, not in imitating extant ones, the latter being both redundant and economically ill-advised. But this seemingly progressive openness to an unknown acoustic futurity was of course itself also a way of displacing the threat posed to the organic notion of the acoustic by synthetic sound—a tree made of wood but that can never bloom!: "*Unheimlich*," writes the critic of the *Frankfurter Zeitung*, "the degree to which technology unceasingly renders superfluous in all domains both organic creation and the natural labors of man!"[55] Nowhere is this clearer than in the simultaneous amazement and horror in response to the prospect—possibly envisioned by Pfenninger but (as far as I know) never realized—of outdoing Humphries by making a full-length "talkie" with entirely synthetic voices, a film in which, as one critic put it, "words will be spoken which belong to no person!"[56] Even critics willing to admit that all instrumental music was, as such, necessarily mechanical, had always insisted that the voice remained the residuum of the extra-technological: "Actually all music is mechanical, with the sole exception of human singing. For all music is made with machines—only the larynx is organic."[57] Pfenninger's technique effectively meant that—at least in theory—this long-standing claim was simply no longer valid.

Following the Pfenninger premieres in late 1932, comparisons with Fischinger's work first begin to appear in print. While a few journalistic accounts are content merely to note the seeming similarity of the two projects, most cast the Fischinger-Pfenninger juxtaposition in terms—*basic impulse* versus *logical conclusion, decorative* versus *analytic*—that imply that it was a question not of who was the first to "discover" synthetic sound but rather of two related but, in the

Opposite: 1932 Emelka publicity photograph with the caption, "This is how Rudolf Pfenninger's 'Sounding Handwriting' is drawn."

Left: "The curve of the sound 'n'; This is how complex the sound 'a' looks in sound writing."

last analysis, very different projects.[58] This is the sense conveyed in the roundup of German cinema for the year 1933 published by Andor Kraszna-Krausz in *Close-Up:*

> two Germans who work on films have announced that they want to transpose phonetically with the photo cell the light reactions of plastics, and to compose them with their parallel visual impressions to obtain sound film accords.
>
> This extremity must have been suggested by the experiments of Oscar Fischinger whose compositions of dancing lines are the only kind of abstract film which can be found in the regular programme of the German cinemas, and which are well received by the public. Fischinger, who originally by synchronisation of his studies made real record pieces, has been trying recently—in order to obtain a more complete unity of picture and sound—to record decorative music in the *Lichtongerät* (light-sound) apparatus.
>
> Simpler, more thorough and practical seem to be the similar endeavours of Rudolf Pfenniger [*sic*], who after a long and difficult analysis, was successful in the calculation of sound writings, and also in drawing them with the hand.[59]

And indeed, upon closer examination of the manner in which each of these inventors *frames* his activities, it becomes clear that despite the superficial similarity they are each pursuing very different goals. Fischinger, as he himself is the first to admit, is basically interested in exploring the relationship between given graphic forms and their acoustic correlates, and how that isomorphism might allow one to make cultural-physiogonomic comparisons. When, for example, he suggests that "we should investigate the ornaments of primitive tribes in terms of their tonal character"[60] it is clear that his point of departure is the graphic mark. Besides this sociological interest, Fischinger also repeatedly argues that hand-drawn sound restores an artistic "sovereignty" to the filmmaker by once again giving him control over elements that the studio system had delegated to specialists. Invoking a rather hackneyed topos from romantic aesthetics, Fischinger insists that "real" art cannot tolerate such collective production because "this in the truest sense most refined and highest artistic activity comes to be only through, and directly out of, a singular personality, and the artwork that arises in this manner—for example works by Rembrandt, Bach or Michelangelo—are immediate creations of the highest power and profit *precisely from their handwritten*, irrational and personal qualities."[61] Despite the fact that, in what might well be an amusing tip of the hat to Pfenninger, the article from

1932 Emelka publicity photograph with the caption, "In the sound strip archive. Based on the score, the pitches that are needed are chosen to be photographed."

which this passage is taken is signed "Engineer Oskar Fischinger," it is clear that for Fischinger handwritten sound, indeed writing per se, is entirely in the service of a thoroughly anti-technological (irrational) artistic intention: "hand-made film renders possible pure artistic creation."[62]

Nothing could be further from the impulse behind engineer Pfenninger's fundamentally pragmatic and sober scientific investigations. Eschewing aesthetic discourse entirely, Pfenninger focused on the technological development of a new form of acoustic writing, a semio-pragmatics of sound whose function was to liberate composition from the constraints of both the extant musical instrumentarium and reigning notational conventions. Unlike Fischinger, who began with graphic forms and then explored what sort of sounds they produced, Pfenninger's primary focus was on the acoustic, in an attempt to establish what the precise wave form is that would allow one to re-produce a specific sound at will. Despite the potential visual appeal of their sine-wave forms, Pfenninger's curves are decidedly *not* ornaments but are rather, as numerous critics have rightly noted, "templates or print-types"[63]; that is, semiotic entities that can be combined to produce sounds in a linguistic—which is to say, thoroughly technical and rule-governed—manner. Unlike Fischinger's curves, which were continuous, Pfenninger's were discrete units. Indeed, in what is perhaps the most succinct manner of differentiating the two projects, while Pfenninger could (at least in theory) have used his method to re-produce every sound made by Fischinger's ornaments, the opposite is obviously not the case. Thus it is no surprise that from the start critics rightly insisted that Pfenninger's invention was not an ornamental practice as much as it was a new technique of acoustic notation, even going so far as to claim that he was in the process of "constructing a contrivance resembling a typewriter which, instead of letters, will set together sign waves in succession."[64]

Pfenninger's discovery was threatening not only because it challenged the hegemony of certain tonal systems (since graphic sound is both entirely free of overtones and entirely compatible with quarter-tone and other scale systems), but also because it represented a fundamental shift in the *status* of recorded sound. As pointed out most clearly in an anonymous review in the *Völkischer Beobachter* [*sic*], prior to Pfenninger, all recorded sound was always a recording *of* something—a voice, an instrument, a chance sound: "in this system, something audible can be recorded by the microphone only if it really exists; i.e., if it was produced somewhere *beforehand*. Rudolf Pfenninger, however, produces tones from out of nowhere."[65] If Pfenninger's synthetic generation of sound effectively *destroyed the logic of acoustic indexicality* that was the basis of all prior recorded sound, it also exposed the *residual iconic-indexicality* in Fischinger's

only seemingly similar activities. Indeed, the experimental fascination with establishing the acoustic correlates *of* a profile or *of* a particular visual form at some level always also assumes that such sounds are sounds *of* something, even if that something is now simply a recognizable graphic trace. Thus, to the extent that Fischinger's work explores and uses the sounds made by various extant things (in his case, graphic forms), his work could be described as a sort of proleptic *musique concrète*, while Pfenninger's synthetic practice is closer to certain nonreferential, acoustically constitutive practices of electronic music. To the extent that Fischinger's ornaments function semiotically, they do so as "motivated" signs, whereas Pfenninger's curves depend, strictly speaking, on only the particular—and in the last analysis, arbitrary—properties of the selenium cell that is the basis of the particular optical cinema sound system he used to produce his sonic graphematics. And it is this crucial semiotic difference that ultimately explains why Paul Seligmann, a member of *Das neue Frankfurt* film club for whom Moholy-Nagy had screened works by both Fischinger and Pfenninger, credits only Pfenninger and not Fischinger with the invention of a functional system of acoustic writing: "It is in the end Pfenninger who discovered the path to acoustic writing. While Fischinger merely photographs sound as a process, Pfenninger captures it as individual images, which led him to develop templates by means of which particular sounds and sound groups can be repeated at will."[66] Indeed, in its rigorously systematic character, Pfenninger's research deserves to be compared closely not with Fischinger but rather with the very similar—and similarly analytic—investigations into synthetic sound undertaken at the same time in the Soviet Union by Nikolai Voinov and Aleksandr Ivanov, who cut out saw-toothed sound shapes from paper in the form of contoured combs, each representing a halftone, which could then be used repeatedly and in various

combinations much like the basic formal vocabulary of visual animation; and by Evgenii Sholpo, who developed a very successful circular "disc" variation on Voinov and Ivanov's combs.[67]

Recorded Sound in the Age of Its Synthetic Simulatability

If Pfenninger's invention makes it possible to create sounds that—as he put it so wonderfully—come from out of nowhere, why is it, one might wonder, that the synthetic sound that accompanies the various films in the *Tönende Handschrift* series is so banally imitative of extant sonorities, even going so far as rendering Händel's Largo or the Barcarole from Offenbach's *Hoffmanns Erzählungen*? Is this yet another instance of a radically new technology for the generation of sound attempting to legitimate itself not by foregrounding its own unprecedented sonic capacities but by slavishly simulating well-known classical pieces—as was the case, for example, with the early performances that introduced the technological wonder of the Theremin?[68] Whatever the motivation might have been, and however trivial it might seem acoustically at first audition, the *effect* of hearing familiar repertoire emanating from a source that not only involved neither instruments nor musicians but consisted only in the systematic photographing of a graphematic vocabulary for an optical sound track, would have been deeply disturbing. And that discomfort stemmed not least from the fact that, while at this initial stage the sound could still be differentiated from the signature timbre of traditional instruments, it was—at least in theory—only a matter of time and technical refinement until it would no longer be possible to distinguish acoustically a sound generated synthetically from a sound produced by conventional means.

For some critics this immediately suggested that synthetic music would in the future render orchestras superfluous because, as the imaginative reviewer of the *Pester Lloyd* put it, "one could conjure up a phantom orchestra [*Geisterorchester*] which does not exist in reality but whose sounds are simply the result of an act of drawing."[69] Indeed, Fischinger himself effectively implied as much, rearticulating in some of his essays on hand-drawn sound Stuckenschmidt's earlier argument that music machines such as the gramophone would eliminate the necessity of the live performing musician as an intermediary between composition and realization. However, given the labor-intensive conditions of Pfenninger's synthetic sound techniques, it was hardly likely that synthetic sound would restage in an even more drastic fashion the all-too-recent labor-political drama that was the consequence of the advent of the gramophone and later the sound film (both of which eliminated in stages the need for full-time musical ensembles to accompany screenings).[70]

What the advent of synthetic sound *did* fundamentally change however was the ontological stability of all recorded sound. The introduction of optical film sound in the late-1920s had already made possible a previously unavailable degree of postproduction *editing,* thereby undermining the *temporal* integrity of acoustic recordings, which could now be patched together out of various takes at various times.[71] The invention of a functional means of generating synthetic sound, however, seemed likely to push this challenge to the so-called authenticity of sound recordings even further. Although it was unlikely that one would be able in the near future to create entire compositions by synthetic means *ex nihilo*—or perhaps better, *ex stylo*—what was decidedly possible was minimal and punctual interventions into the fabric of extant recordings. This is precisely what Humphries had done—incorporating just a few unnoticeable substitutions into the otherwise intact optical soundtrack of a film. But what made these changes so disturbing was precisely the fact that, while indistinguishable from the rest of the spoken words, Humphries's synthetic voice was just that—synthetic—and thus opened up a fundamental doubt about the status of *everything* on the soundtrack. Indeed, the extent of the critical reaction to his efforts was itself a good barometer of the threat they represented to a certain—indexical—ideology of recorded sound. For while the cut threatens the integrity of the recording as a continuous event, it does not in any way undermine the indexicality of the recording process as such, which continues to govern all of the now rearranged pieces just as much as it did before they were edited. Pfenninger's invention of synthetic sound, on the other hand, represents nothing less than the incursion into the acoustic domain of postproduction composite adjustments–often referred to as "corrections" or "improvements"—that are no longer of the order of the indexical. No longer the re-phenomenalized trace of a prior acoustic event, as tones from out of nowhere, they are no longer sounds *of* anything but are, instead, simply a set of *graphic* (i.e., non-acoustic) instructions.

Most of the reactions to the *Tönende Handschrift* simply registered the profound anxiety that the undermining of sonic indexicality provoked—without being able to articulate its sources: typical in this regard is the statement "the consequences of this discovery are so monstrous, so spooky, that at this moment we cannot fully grasp them."[72] One particularly astute critic was, however, able to identify exactly what was at stake:

> Just as a photographic plate can be retouched and beautified by the art of the photographer, in a similar manner one will be able to modify the spoken word, the sound and modulation of the human voice, to its utmost perfection. A wide domain of acoustic re-touching has here opened up for the

film industry, and no singer will ever again run the risk of not having been able to hit the high C perfectly.[73]

Once off-pitch notes can be corrected, late entries adjusted, disturbing overtones eliminated, and unpleasant sonorities rendered more agreeable, then every recording of music can in theory be "perfect." Indeed, as Herbert Rosen insists, such tweaked productions might, in fact, sound better than the "originals": "Indeed, we will even go so far as to say that all these presentations will be significantly better, purer and more lacking in any blemishes than the authentic recordings! Since all the contingent possibilities on the one hand, and all the shortcomings that are characteristic of a number of musical instruments on the other, will now be eliminated by the sounding handwriting."[74] But this new quality in recorded music is, of course, bought at a price, since now one can no longer "know" what exactly the status is of the performance it registers. In other words, a technological doubt has been introduced into the indexical readability of recorded performance. At any point what one is hearing might be the product of a synthetic, Pfenningerian postproduction intervention that is unrecognizable as such. This is the beginning of a far-reaching undecidability—recorded sound in the era of its referential ambiguity—that, decades later and in the wake of a much expanded repertoire of studio interventions, would lead to the rise of "direct-to-disc" mastering and so-called live recordings as an (ultimately futile) attempt to restore the prelapsarian untroubled indexicality of recorded sound prior to the moment of its synthetic simulatability.

Coda: The Afterlife of Synthetic Film Sound

As it turns out, the five films in the *Tönende Handschrift* series—the first results of Pfenninger's experimentation with synthetic sound—were also his last. In a 1953 interview Pfenninger explained the lukewarm response to his invention in the early 1930s as follows: "The time was not ripe, my invention came twenty years too early."[75] Or perhaps too late: only a few years later Pfenninger's films would be designated "seelenlos und entartet" (soul-less and degenerate) by the

1932 Emelka publicity photograph with the caption, "The inventor photographing the sound measure by measure."

Nazis,[76] and thus, not surprisingly, work in this domain effectively came to a halt. While Moholy-Nagy himself explored some of the challenges raised by Pfenninger's technique in 1933 in the form of a short experimental film entitled *Tönendes ABC* (Sounding ABC) whose optical sound track was rephotographed such that it could be projected on the image track simultaneously with the sound (allowing one to *see* the same forms that one was also *hearing*),[77] besides a brief mention of synthetic sound in W.L. Bagier's 1934 documentary *Der Tonfilm,* Germany would quickly cease to be the fertile ground for work on synthetic film sound that it had been for the previous few years.[78]

Elsewhere, however, especially in the wake of the extensive publicity surrounding the release and international distribution of the *Tönende Handschrift* series, "Hand-drawn sound" quickly became something of an international sensation, albeit a very brief one. In America even commercial films such as Rouben Mamoulian's 1931 *Dr. Jekyll and Mr. Hyde* took advantage of the uncanny acoustic possibilities afforded by the new technique as a means to provide a sonic correlate to the transformation of the gentleman into the monster and vice versa. The result was, as one commentator described it, "a vivid, synthetically created sound track built from exaggerated heart beats mingled with the reverberations of gongs played backwards, bells heard through echo chambers and completely artificial sounds created by photographing light frequencies directly onto the soundtrack."[79] In France, following a few articles on *Die tönende Handschrift* in French and Belgian journals,[80] hand-drawn sound began to appear in film sound tracks, most notably in the work of Arthur Hoérée whose practice of *zaponage,* a technique that involves using a dark paint or stain called Zapon to touch up the optical sound track, was employed to great effect in Dimitri Kirsanoff's 1934 *Rapt.*[81] While I have not been able to establish the extent to which actual synthetic sound appeared in Italian film, the issues involved were at the very least known there; for example, the German music theorist Leonhard Fürst (who had written about Fischinger in *Melos*) gave a lecture on new techniques of film sound on May 2, 1933, at the International Music Conference which took place during the May Festival in Florence. Following this lecture, which included screenings of a reel of Fischinger's *Tönende Ornamente,* Eisenstein's *Romance Sentimentale* (France, 1930), and Pfenninger's *Tönende Handschrift,* explanatory essays began to appear on the subject in both technical and touristic journals.[82] In the Soviet Union the fruits of the wide-ranging local research into synthetic sound began appearing in the sound tracks of films such as *Plan velikikh rabot* (*Plan of Great Works*, 1931), *Kem bït* (*Who to be*, 1931), and *Gibel sensatsii* (*The end of a sensation*, 1931), and then somewhat later in *Symphony of the World* (Soviet Union, 1933), in the "Ivoston" group's 1934 *Prelude*

Top, left: Cards containing sound-wave patterns which, when photographed, produce musical sounds. Published in Maynard Collins, *Norman McLaren*, 1976.

Top, right: McLaren "composing" a film score using cards containing sound-wave patterns. Published in *Norman McLaren*.

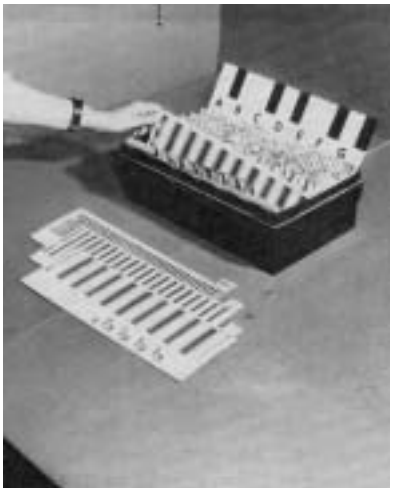
Bottom: Film strip with hand-drawn sound and image from "Loops" (Norman McClaren. 1940). Published in *Norman McLaren*.

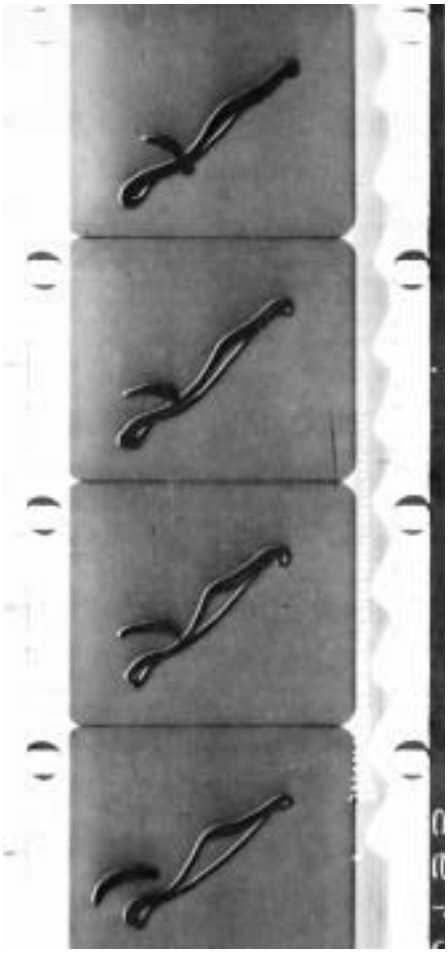
by Rachmaninoff, and in Grigori Alexandrov's short collaboration with Sergei Eisenstein entitled *Romance Sentimentale.*

In the wake of Humphries's sensational 1931 breakthrough in London one might have expected, in turn, that quite a lot of new work would be done on synthetic sound in England. While this seems not to have been the case (although it is entirely possible that synthetic sound continued to be used discretely by the major studios when needed), the British interest in the subject did, however, lead to what is arguably the most significant *reception* of work in synthetic sound done elsewhere. Pfenninger's technical breakthrough was reported at length in numerous richly illustrated articles in British professional journals such as *Wireless World* and *Sight and Sound*.[83] At about the same time—and in addition to the already mentioned London Film Society screenings of synthetic sound films by Fischinger on May 21 and December 10, 1933 (the latter with Moholy-Nagy's *Tönendes ABC*), and a screening of *Die tönende Handschrift* on January 14, 1934 (described in the program notes as "the most elaborate attempt so far made to use synthetic sound for cinema purposes")—on January 13, 1935, the Film Society screened a double bill of films *about* sound: Bagier's *Der Tonfilm* and the British documentary *How Talkies Talk* (Dir. Donald Carter, 1934), which the program notes describe as follows:

> Two films showing the different system of sound recording. Of special technical interest in the English film is the actual photography of the photographic trace of the light beam which was developed while it was being filmed. The process of recording is normally carried out in the dark, but, by choice of the right film stock for the motion picture camera, and by illuminating the scene with a light which does not affect positive film (on which the recording is done), a picture has been obtained of the actual recording sound waves. The sounds which are shown are synthetic, but they follow the mechanical wave form of sound.[84]

It was also in London, just over a year later, that a young Scottish art student was hired by John Grierson to work for the General Post Office (GPO) Film Board. This student, Norman McLaren, would go on to become arguably the world's most well-known and prolific proponent of synthetic sound. In the years following the above mentioned screenings and articles, McLaren began his first experiments with synthetic sound, scratching directly onto the sound track in an improvised manner for *Book Bargain* (1937), to take just one example from his time with the GPO film unit, and in the abstract films *Allegro, Dots, Loops,* and *Rumba* (the last consisting of only a sound track without visuals), which he made in 1939 for the Guggenheim, then known as the Museum of Non-Objective



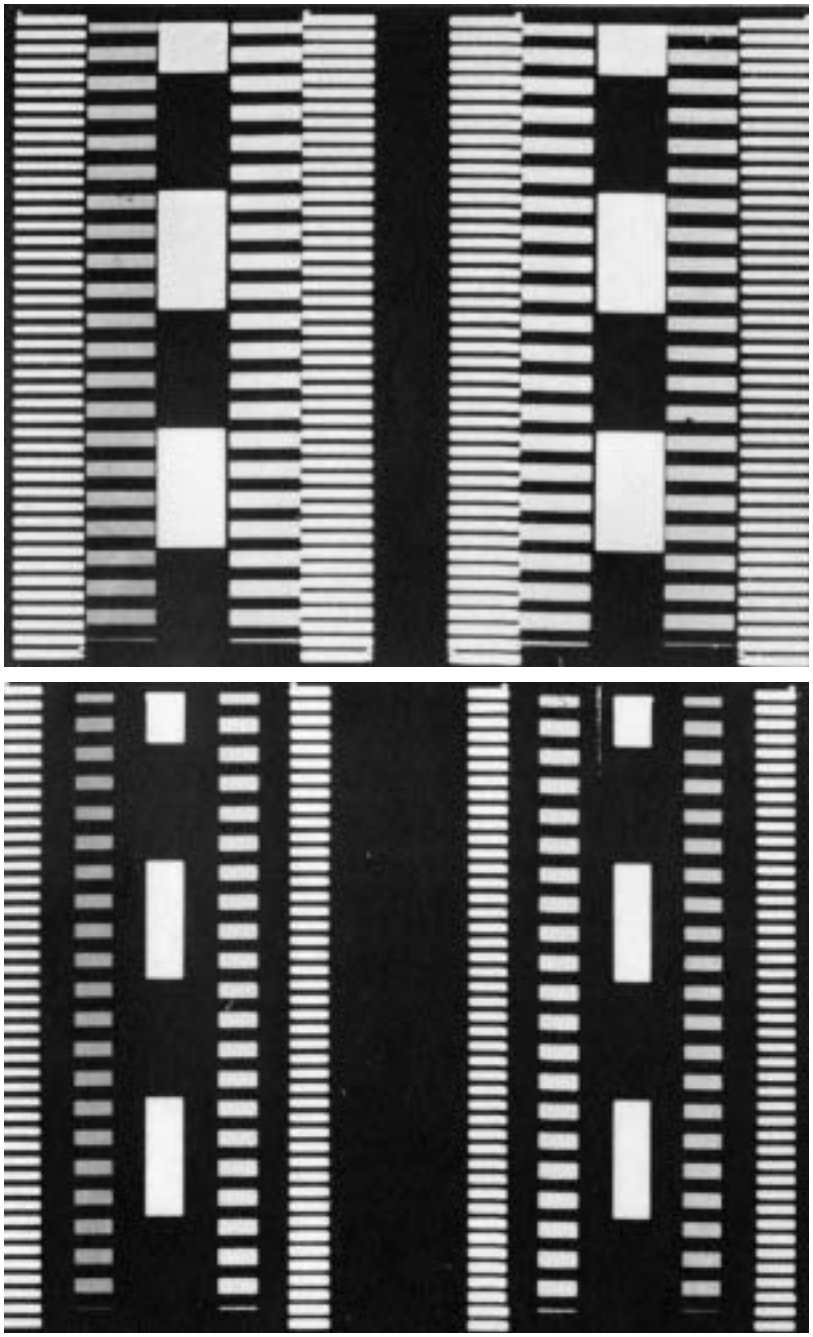


Paintings, in New York. But when asked about the inspiration for the much more systematic technique of generating synthetic sound that he developed in the early 1940s, McLaren credits the Continental experimental films shown at the Glasgow School of Art, where he had studied from 1932 to 1936:

> Amongst them was a film called *Tonal Handwriting* made by a German engineer from Munich—Rudolph Phenninger [*sic*]. He had evolved a system. First of all, the film consisted of a documentary showing how he did it. He had a library of cards and a camera. He'd pull out a card, film a frame and so on, and then at the end of that he had a little cartoon. He had music with this, quite lively, not distinguished, but very lively. This is the basis on which I developed my card system.[85]

It was this neo-Pfenningerian method of "synthetic animated sound"—involving a library of one-by-twelve-inch strips each, with from one to 120 iterations of a hand-drawn sound-wave pattern that could produce every semitone across a five-octave range—which McLaren used in later films with synthetic soundtracks such as the stereoscopic *Now Is the Time* (1951), *Two Bagatelles* (1952), the Oscar-winning *Neighbors* (1952), and *Blinkety Blank* (1955). McLaren detailed his method in a series of introductory and technical essays that would be instrumental in disseminating the technicalities of the procedure.[86] Using this technique, McLaren produced for the National Film Board of Canada what is arguably the magnum opus of the synthetic sound film, the seven-minute-long *Synchromy* (1971), in which one sees the abstract patterns that are at every moment creating the sounds that one is hearing. The result, as described by a contemporary critic, is "a fascinating exercise in the 'perception' of sound."[87]

The subsequent chapters in the rich and fascinating history of synthetic sound—which is, alas, far too extensive a subject to be dealt with here—unfold



across a number of domains, ranging from avant-garde cinema (especially experimental animation) to the development of new notational systems and technologies for the production of sound. The former includes, to take just three examples, the work of the Americans John and James Whitney in the 1940s (who employed a pendulum device to generate an entirely synthetic optical sound track for the "audio-visual music" of their *Five Abstract Film Exercises* of 1943–1945), the experimental short *Versuch mit synthetischem Ton* (Test) by the Austrian underground filmmaker Kurt Kren in 1957 (with an entirely "scratched" optical sound track), and the films of Barry Spinello in the 1960s (whose synthetic sound tracks—for example in *Soundtrack* (1970)—were generated both by drawing

Film stills from *Synchromy*. Dir. Norman Mclaren, 1971. Soundtrack shifted on to the image track; what you see is what you hear. Published in Valliere T. Richard, *Norman McLaren, Manipulator of Movement*, 1982.

and painting directly on the celluloid and by means of self-adhesive materials such as microtape and press-apply lettering).[88] The latter locates Pfenninger's method in the complex history of the invention of new recording media such as magnetic tape and of new synthetic sound technologies such as Harald Bode's 1947 melochord (which was used in the 1950s in Stockhausen's studio for electronic music in Cologne), Harry F. Olson's famous RCA Electronic Music Synthesizer (which was first introduced in 1955), Robert Moog's pathbreaking modular synthesizer built in 1964, and the later proliferation of MIDI interfaces that have rendered the experience of, and work on, music as a graphic material an almost quotidian affair.

But besides its genealogical importance, Pfenninger's *Tönende Handschrift* is also of great, thoroughly contemporary *theoretical* interest, offering as it does a remarkable proleptic parallel in the domain of the acoustic to the development that is at this moment transforming the status of much visual representation. If, as some have argued, the advent of digital imaging has thrown into question many of the referential assumptions that heretofore characterized the various fundamentally indexical nineteenth-century visual media such as photography and cinema, then the aesthetico-political consequences of this paradigmatic shift are of fundamental importance. Just as Pfenninger's technique of synthetic sound—especially when it operates as a simulacral "correction" of traditional sonic material within an otherwise indexical recording—fundamentally undermines the presumed *homogeneity* of the indexical field, opening it up to a doubt whose epistemologically contaminatory consequences cannot be contained, so too does the increasing prevalence of a similar semiotic hybridity in the visual domain—such as, to take an obvious example, the completely computer-rendered 3-D creatures that inhabit an otherwise live-action cinematic landscape in the Disney film *Dinosaur* (Dir. Eric Leighton, 2000)—throw the indexical status of the entire visual field into question. In light of Lev Manovich's suggestion that in media-historical terms the advent of the digital episteme can be described as a turn from an optical to a *graphic* mode of representation that in fact characterized the nineteenth-century media out of which cinema was developed,[89] the essentially graphematic nature of Pfenninger's synthetic sound technique in turn reveals a key dimension of this graphic turn of new media—its fundamental status not so much as drawing but qua inscription as a techno-logics of writing.

Notes

This essay is part of a much longer forthcoming study of the genealogy of synthetic sound whose initial phases were generously supported by the Pro Helvetia Stiftung and the Princeton University Committee on Research in the Humanities and Social Sciences. Further helpful input, access to materials, and suggestions were kindly provided by Jan-Christopher Horak (then at the Munich Film Archive), William Moritz (Iota Foundation, Los Angeles), Roland Cosandey (Vevey), and Rebecca Gomperts (Amsterdam). I would especially like to thank Sigrid Weigel (then Director of the Einstein Forum, Potsdam) for the opportunity to first present this material at the 1999 Potsdam conference on the "Cultural and Media History of the Voice," and Daniela Peters for her helpful and intelligent editorial support. This essay first appeared in German as "'Töne aus dem Nichts'. Rudolf Pfenninger und die Archäologie des synthetischen Tons" in: Friedrich Kittler, Thomas Macho and Sigrid Weigel, Eds., *Zwischen Rauschen und Offenbarung: Zur Kultur- und Mediengeschichte der Stimme* (Berlin: Akademie Verlag, 2002), pp. 313–355. It is dedicated to the accomplished film animator Marianne Pfenninger, who so graciously and unhesitatingly gave me access to the archive of her late father's pioneering work.

1. "Synthetic Speech Demonstrated in London: Engineer Creates Voice Which Never Existed," *New York Times,* 16 February 1931: 2.

2. On the institutional history of the development of these pioneering optical sound systems in Europe and the United States, see Douglas Gomery, "Tri-Ergon, Tobis-Klangfilm, and the Coming of Sound," *Cinema Journal* 16, no. 1 (Fall 1976): 50–61. On the early history of the Tri-Ergon unit at UFA, see Hans Vogt, *Die Erfindung des Tonfilms* (Erlau: Vogt, 1954), Wolfgang Mühl-Benninghaus, *Das Ringen um den Tonfilm: Strategien der Elektro- und derFilmindustrie in den 20er und 30er Jahren* (Düsseldorf: Droste, 1999), esp. 21–41, and Guido Bagier, "'Ton mehr aufdrehen—verstärken!'" in *Das Ufa-Buch,* ed. Hans-Michael Bock and Michael Tötenberg, 244–247 (Frankfurt/M.: Zweitausendeins, 1992). For details on the prehistory and early triumphs of the Vitaphone system, see Mary Lea Bandy, ed., *The Dawn of Sound* (New York: The Museum of Modern Art, 1989).

3. See Wolfgang von Kempelen, *Mechanismus der menschlichen Sprache nebst der Beschreibungen einer sprechenden Maschine* (1791; reprint, in facsimile form, Stuttgart-Bad Cannstatt: Friedrich Frommann Verlag, 1970), 183.

4. Friedrich Kittler, *Gramophone, Film, Typewriter*, trans. Geoffrey Winthrop-Young and Michael Wutz (Stanford: Stanford University Press, 1999): 83; trans. modified. First published as *Grammophon, Film, Typewriter* (Berlin: Brinkmann & Bose, 1986), 129.

5. For a fascinating discussion of the function of acoustic technologies in the nineteenth-century debates on language transcription and phonetics, see Wolfgang Scherer, "Klaviaturen, visible speech und Phonographie: Marginalien zur technischen Entstellung der Sinne im 19. Jahrhundert," in *Diskursanalysen I: Medien,* ed. Friedrich Kittler, Manfred Schneider, and Samuel Weber, 37–54 (Opladen: Westdeutscher Verlag, 1987).

6. Scherer, "Klaviaturen, visible speech und Phonographie," 48. It was this very Henry Sweet who later served as the model for Professor Higgins in G. B. Shaw's *Pygmalion*.

7. His account of the event can be found in Count [Theodor A.L.] du Moncel, *Le Téléphone, le microphone et le phonographe* (Paris: Hachette, 1878). The anecdote is cited from the "Authorized

translation with additions and corrections by the Author," published as *The Telephone, the Microphone and the Phonograph* (1879; reprint, New York: Arno Press, 1974), 244–245.

8. Kittler, 59. Indeed, as Kittler goes on to explain, Berliner's gramophone gained its worldwide popularity as a flat disc technology that delivered sound "pre-recorded" by the record industry while Edison's (cylinder) phonograph enabled individual users themselves to record and store the sounds of daily life but as a result remained a very private (and thus commercially much less lucrative) medium.

9. Alfred Mayer, "On Edison's Talking-Machine," *Popular Science Monthly,* 12 March 1878, 723.

10. H[arry] A. Potamkin, "'Playing with Sound,'" in *The Compound Cinema: The Film Writings of Harry Alan Potamkin,* ed. Lewis Jacobs (New York: Teacher's College Press, 1977), 87. First published in *Close Up* 7, no. 2 (August 1930). Reprinted as a facsimile in *Close Up: A Magazine Devoted to the Art of Films,* vol. 7: *July–December 1930,* ed. Kenneth Macpherson and Bryher (New York: Arno Press, 1971), 114.

11. This account of Dyer's testimony at the congressional hearings can be found in Lisa Gitelman, "Reading Music, Reading Records, Reading Race: Musical Copyright and the U.S. Copyright Act of 1909," *The Musical Quarterly* 81, no. 2 (Summer 1997): 275. Reprinted in an expanded version as Chapter 3, "Patent Instrument, Reading Machine" in Lisa Gitelman, *Scripts, Grooves, and Writing Machines: Representing Technology in the Edison Era* (Stanford: Stanford University Press, 1999): 97–147.

12. "Die Frage, ob die Eindrücke auf den Platten und Walzen als Schriftzeichen im Sinne des § 41 St. G.B. anzusehen seien, müsse bejaht werden. Die Laute der menschlichen Stimme würden beim Phonographen in gleicher Weise fixiert wie durch die Buchstabenschrift. Beide seien eine Verkörperung des Gedankeninhaltes, *und es mache keinen Unterschied, daß die Buchstabenschrift diesen Inhalt durch das Auge, der Phonograph ihn aber durch das Gehör vermittele,* denn auch die Blindenschrift, die ihn durch das Tastgefühl vermittele, sei eine Schrift im Sinne des § 41," "Die Sprechmaschinenschrift und die bestehenden Gesetze," *Phonographische Zeitschrift* 7, no. 9 (1906): 198. (Unless otherwise noted, all translations are author's own.)

13. Alexander Melville Bell, *Visible Speech: The Science of Universal Alphabetics; Or Self-Interpreting Physiological Letters for the Writing of All Languages in One Alphabet* (London: Simpkin, Marshall, 1867). See also Scherer, "Klaviaturen, visible speech und Phonographie," 49f. Interestingly, this difference in focus was already manifest at the turn of the century, as evidenced by the opening line of a 1903 editorial that reads: "Strangely enough, phonographic writing is generally of greater interest to linguists than it is to phonograph technicians." "Die phonographische Schift auf den Platten von Plattensprechmaschinen," *Phonographische Zeitschrift* 4, no. 42 (1903): 577.

14. Both L. Hermann in 1890 and Bevier in 1900, for example, used a mirror mounted on a fine tracing device such that it reflected a beam of light onto a film which thereby registered photographically the outlines of the phonographic squiggles, while a later apparatus developed by a certain appropriately named Edward Wheeler Scripture was able to generate a graphic translation of the contents of the phonographic grooves magnified over 300 times laterally and five times in length. These and numerous other devices are discussed at length in the remarkable early study by Dayton Clarence Miller, *The Science of Music Sounds* (1916; reprint, New York: MacMillan, 1934). A useful contemporary account of the race to produce a device that would successfully

capture sound waves photographically can be found in the report on "Vorrichtung zur photographischen Aufnahme von Schallwellen," *Phonographische Zeitschrift* 1 (1900): 13. The later fascination of such optical translations of acoustic data for the field of musicology is evident in William Braid White, "Music Made Visible," *Proceedings of the Music Teachers' National Association* 53 (1929): 102–107.

15. Bernard Holland, "A Man Who Sees What Others Hear," *New York Times,* 19 November 1981, C28. According to this article, "Before an audience in the auditorium of Abington Hospital, near Philadelphia, two weeks ago, Stimson Carrow, professor of music theory at Temple University, handed Dr. Lintgen a succession of 20 long-playing records chosen by Mr. Carrow and 10 of his graduate students. All identifying labels and matrix numbers were covered over, but Dr. Lintgen, simply by taking the records in his hands and examining their groove patterns in a normal light, identified the piece and the composer in 20 cases out of 20." This story was also picked up by both *Time* ("Read Any Good Records Lately?" 4 January 1982, 82) and, a few years later, by the *Los Angeles Times* (Al Sekel, "The Man Who Could Read the Grooves," 19 October 1987, B3), the latter story probably provoked by very similar reports about a thirty-three-year-old Englishman named Tim Wilson who made the rounds of British and American talk shows demonstrating his ability to identify unlabeled records simply by "reading" the grooves. At least one contemporary visual artist, K.P. Brehmer, was so inspired by the story that he dedicated a work to him—"Komposition für Tim Wilson II" (1986). More recently, MIT professor Victor Zue, an expert in natural-language processing, amazed research colleagues in the field of speech recognition with his capacity to read what people were saying in spectrographs, the digital translation of a voiceprint.

16. The most recent chapter in this story is the development by a young Israeli computer scientist of software that is capable of visually "reading" a twelve-inch record (using a simple flatbed scanner) and then translating the patterns within the grooves into sounds. While the results of Ofer Springer's transcriptions are described as "barely recognizable as the original music" the purpose of the experiment was not high fidelity but, as Springer himself explains, "to show an audio signal could be visually recoverable from a record." (Leander Kahney, "Press 'Scan' to Play Old Albums?," *Wired News*, see http://www.wired.com/news/digiwood/0,1412,57769,00.html) Downloadable examples of the resulting sonic re-phenomenalizations as well as the souce code for the decoder are available at Springer's homepage www.cs.huji.ac.il/~springer.

17. Douglas Kahn and Gregory Whitehead, eds., *Wireless Imagination: Sound, Radio, and the Avant-Garde* (Cambridge: MIT Press, 1992), 11.

18. Ludwig Wittgenstein, *Tractatus logico-philosophicus* (1921; facing-page German and English edition, with an introduction by Bertrand Russell, London: Routledge & Kegan Paul/ New York: The Humanities Press, 1986): 39; translation modified.

19. Rainer Maria Rilke, "Ur-Geräusch," in *Sämtliche Werke,* vol. 6 (Frankfurt/M: Insel-Verlag, 1966), 1087. First published in *Das Inselschiff* 1, no. 1 (1919/1920): 14–20; translated as "Primal Sound," in Kittler, 39 (translation modified).

20. Kittler, 44. As Kittler puts it: "Before Rilke, nobody had ever suggested decoding a trace that nobody had encoded and that encoded nothing. Ever since the invention of the phonograph, there has been writing without a subject."

21. Kittler, 45.

22. László Moholy-Nagy, "Production—Reproduction," in *Moholy-Nagy*, ed. Krisztina Passuth

(London: Thames and Hudson, 1985), 289–290. First published in *De Stijl* 5 (1922) #7: 97–101.

23. László Moholy-Nagy, "Neue Gestaltung in der Musik: Möglichkeiten des Grammophons," in *Der Sturm* (Berlin) (July 1923) #14 (reprint, in facsimile form, Nendeln, Liechtenstein: Kraus Reprint, 1970), 102–106. In English as "New Form in Music: Potentialities of the Phonograph," in Passuth, *Moholy-Nagy,* 291–292.

24. This is the concluding line of Stuckenschmidt's highly controversial 1925 essay "Die Mechanisierung der Musik," *Pult und Taktstock* 2, no. 1 (1925): 1–8, a text which is reprinted (albeit without the symptomatic introductory disavowal by the journal's editors) in Hans Heinz Stuckenschmidt, *Die Musik eines halben Jahrhunderts: 1925–1975* (Munich and Zurich: Piper, 1976), 15. Compare also Stuckenschmidt's "Maschinenmusik," *Der Auftakt* 7, nos. 7–8 (1927): 152–157. For a representative essay available in English, see his "Mechanical Music," *The Weimar Republic Sourcebook,* ed. Anton Kaes, Martin Jay, and Edward Dimendberg, 597–600 (Berkeley and Los Angeles: University of California Press, 1994). First published as "Mechanische Musik," *Der Kreis* 3, no. 11 (November 1926): 506–508. While the curious development of Stuckenschmidt's critical positions itself merits further treatment than is possible here, it is interesting to note that by 1929, in "Moderne Musik auf der Grammophon-Platte," *Der Auftakt* 9, no. 1 (1929): 12–15, Stuckenschmidt had entirely abandoned his earlier arguments for gramophone-specific music and instead promoted the use of the new medium as a means of disseminating the works of contemporary composers such as Schoenberg.

25. Stuckenschmidt, "Die Mechanisierung der Musik," 15.

26. Stuckenschmidt, "Die Mechanisierung der Musik," 15.

27. For an intelligent treatment of the aesthetic and institutional context of this fascinating moment in twentieth-century music history, and for the rather remarkable story of the recovery of the actual discs with which Hindemith did his experiments in 1930, see Martin Elste, "Hindemiths Versuche 'grammophonplatten-eigener Stücke' im Kontext einer Ideengeschichte der mechanischen Musik im 20. Jahrhundert," *Hindemith-Jahrbuch* 25 (1996): 195–221. For more on the various compositions written especially for the Welte-Mignon rolls, see Werner König, "Über frühe Tonaufnahmen der Firma Welte und die Werke für das Welte-Mignon-Reproduktionsklavier," in *Jahrbuch des Staatlichen Instituts für Musikforschung Preußischer Kulturbesitz 1977* (Kassel: Verlag Merseburger Berlin, 1978), 31–44.

28. See Heinrich Burkard, "Anmerkungen zu den 'Lehrstücken' und zur Schallplattenmusik," *Melos* 9, nos. 5–6 (May–June 1930): 230; and Ernst Toch, "Über meine Kantate 'Das Wasser' und meine Grammophonmusik," *Melos* 9, nos. 5–6 (May–June 1930): 221–222. Compare also Toch's earlier essay, "Musik für mechanische Instrumente," *Musikblätter des Anbruch: Sonderheft Musik und Maschine* 8, nos. 8–9 (October–November 1926): 346–349.

29. See, for example, "Die tönende Handschrift," *Lichtbild-Bühne* (Berlin), 3 December 1932.

30. This passage can be found in a little-known reprint of Moholy-Nagy's 1923 *Der Sturm* essay "Neue Gestaltung in der Musik"—along with a new preface and postface—under the title "Musico-Mechanico, Mechanico-Optico" in a special "Musik und Maschine" issue of the *Musikblätter des Anbruch*, nos. 8–9 (October–November, 1926): 367.

31. Paul Hindemith, "Zur mechanischen Musik," *Die Musikantengilde* 5, nos. 6–7 (1927): 156. Also cited in Elste, "Hindemiths Versuche," 213.

32. László Moholy-Nagy, "Az új film problémái" (1928–1930), *Korunk* 5, no. 10 (1930): 712–719.

In French as "Problèmes du nouveau film," *Cahiers d'art* 8, nos. 6–7 (1932): 277-280. In English as "Problems of the Modern Film," *New Cinema* (#1, 1934), reprinted in *Telehor* (Brno) 2, nos. 1–2 (1936) and Passuth, *Moholy-Nagy*, 314; translation modified.

33. Moholy-Nagy, "Problems of the Modern Film," 314. The section of the citation following the ellipsis reappears, slightly modified, in Moholy-Nagy's later study *Vision in Motion* (Chicago: Paul Theobald, 1947), 277.

34. Moholy-Nagy, "New Film Experiments," in Passuth, *Moholy-Nagy,* 322; emphasis added. This text was first published as László Moholy-Nagy, "Új film-kísérletek," *Korunk* 8, no. 3 (1933): 231–237. In the *Vision in Motion* volume, Moholy even reproduces two photographs of Pfenninger working on the production of synthetic sound tracks, quite possibly the first publication of these images in book form: Moholy-Nagy, *Vision in Motion,* 276–277.

35. -f., "Film-Experimente: Zu einer Matinée im Frankfurter Gloria-Palast," *Rhein-Mainische Volkszeitung,* 5 December 1932. Besides Moholy-Nagy, the impressively cosmopolitan and theoretically sophisticated lecture series which the film club of "das neue Frankfurt" ran parallel with its screenings also featured speakers such as Rudolf Arnheim, Paul Seligmann, Joris Ivens, and Dziga Vertov. The 1932-1933 program of screenings and lectures is reprinted in Heinz Hirdina, ed., *Neues Bauen/Neues Gestalten: Das neue Frankfurt/die neue Stadt. Eine Zeitschrift zwischen 1926 und 1933* (Dresden: Verlag der Kunst, 1984; reprint 1991), 341.

36. Typical, in this regard is the statement by the historian of animation Gianni Rondolino: "*Tönende handschrift,* realizzato da Pfenninger nel 1930–31, è forse il primo essempio di musica sintetica." Rondolino, *Storia del cinema d'animazione* (Torino: Einaudi, 1974), 141. A rare extended treatment of this curiously neglected acoustic moment in the history of avant-garde cinema can be found in Hans Schleugl and Ernst Schmidt Jr., *Eine Subgeschichte des Films. Lexikon des Avantgarde-, Experimental- und Undergroundfilms,* vol. 2 (Frankfurt/M: Suhrkamp, 1974), 938–940. On the other hand, in what is otherwise a well-informed and wide-ranging account of the subject, there is no mention of Pfenninger whatsoever in Robert Russett, "Experimenters in Animated Sound," in *Experimental Animation: Origins of a New Art,* rev. ed., ed. Robert Russett and Cecile Starr, 163–177 (New York: Da Capo, 1976), nor in the otherwise intelligent assessment of "Avant-garde early sound films" in Russell Lack, *Twenty Four Frames Under: A Buried History of Film Music* (London: Quartet Books, 1997), 104–111.

37. One of the few texts in English that focuses on this fascinating and largely unknown chapter, which I explore at some length in my forthcoming study, is Nikolai Izvolov, "The History of Drawn Sound in Soviet Russia," trans. James Mann, *Animation Journal* 7 (Spring 1998): 54–59. See also Hugh Davies, "Avraamov, Arseny Mikhaylovich," in *New Grove Dictionary of Musical Instruments* 1, ed. Stanley Sadie (London: MacMillan Press, 1984), 91; Davies, "Sholpo, Evgeny Aleksandrovich," in *New Grove Dictionary of Musical Instruments* 3, ed. Sadie, 377; and Davies, "Variaphon" [*sic*], in *New Grove Dictionary of Musical Instruments*, ed. Sadie, 716.

38. The most extensive and well-informed overview of Fischinger's work can be found in William Moritz, "The Films of Oskar Fischinger," *Film Culture* 58–60 (1974): 37–188. More recently, Moritz contributed a lengthy study, entitled "Oskar Fischinger," to the catalogue *Optische Poesie: Oskar Fischinger Leben und Werk* (Frankfurt/M: Deutsches Filmmuseum, 1993), 7–90. On the history of early abstract cinema, see also *Film as Film: Formal Experiment in Film, 1910–1975* (London: Hayward Gallery/Arts Council of Great Britain, 1979): 9–35; Standish Lawder, "The

Abstract Film: Richter, Eggeling and Ruttmann," in Lawder, *The Cubist Cinema* (New York: New York University Press, 1975), 35–64; and Hans Richter, "Avant-Garde Film in Germany," in *Experiment in the Film,* ed. Roger Manvell, 219–233 (London: The Grey Walls Press, 1949).

39. As reported in numerous journalistic accounts of Diebold's lectures on "den gezeichneten Film" (hand-drawn film) in the Südwestdeutschen Rundfunk ("Bernhard Diebold vor dem Mikrophon," *Frankfurter Zeitung,* 18 June 1932) and in the cinema Kamera Unten den Linden (H.A., "Bernhard Diebold über Fischingerfilme: 'Das ästhetische Wunder,'" *Lichtbildbühne,* 1 June 1932).

40. This description is from the program note to a screening of Fischinger's "Early Experiments in Hand-Drawn Sound" at The Film Society in London on May 21, 1933. The note is reprinted in *The Film Society Programmes 1925–1939* (New York: Arno Press, 1972), 277. Although the program lists the date of these experiments as 1931, entry no. 28 in Moritz, "The Films of Oskar Fischinger," entitled "Synthetic Sound Experiments," is described as "several reels of sound experiments from 1932 [that] survive in marginal condition." On December 10, 1933, the Film Society screened another program of Fischinger films entitled "Experiments in Hand-Drawn Sound," dated 1933. The 1993 Fischinger filmography *Optische Poesie* includes only one entry, however, entitled *Tönende Ornamente* (Sounding Ornaments) and described as follows: "Experimente mit gezeichneter Lichttonspur (Experiments with hand-drawn optical soundtrack) s/w, Ton, 123 m, 5 min. (weiter 500 m auf Nitrat erhalten)" (106).

41. Moritz, "The Films of Oskar Fischinger," 51. According to another source, Fischinger made a similar discovery with the geometric motif that the ancient Egyptians used to designate the snake: when reproduced on the optical sound track, the acoustic result was exactly the hiss characteristic of this animal! See Georges Hacquard, *La Musique et le cinéma* (Paris: PUF, 1959), 34.

42. "Persönliche, nationale, charakteristische Eigentümlichkeiten werden sich naturgemäß auch im Ornament ausdrücken lassen. Der Deutsche bevorzugt bei seinem Stimmansatz einen heftigen Anschlag. Dies entspricht einer bestimmten heftigen Kurve, während des Franzosen weicher Ansatz sich auch entsprechend im Ornament anders gestaltet. Es gibt also auf diese Weise eine ebenso deutliche 'Mundschrift' wie es eine 'Handschrift' gibt." Oskar Fischinger, "Klingende Ornamente," *Kraft und Stoff* (suppl. to *Deutsche allgemeine Zeitung*) 30 (28 July 1932). This edition includes extensive illustrations. The text was reprinted, albeit with occasionally significant variations, as "Tönende Ornamente: Aus Oskar Fischingers neuer Arbeit," *Filmkurier,* 30 July 1932; and "Klingende Ornamente! Eine neue Basis der Kunst?" *Saarbrücker Landeszeitung,* 11 September 1932. A typescript in the Fischinger Papers in the Iota Foundation Archive (Los Angeles) bears the title "Klingende Ornamente, absoluter Tonfilm" (Sounding Ornaments, Absolute Sound Film), and another textually identical typescript carries the title "Der Komponist der Zukunft und der absolute Tonfilm" (The Composer of the Future and the Absolute Sound Film). Interestingly, the passage cited here is dropped in the *Filmkurier* reprint.

43. Although in his 1974 study Moritz writes that this lecture took place a full year earlier in August 1931 (Moritz, "The Films of Oskar Fischinger," 52), in his 1993 essay on Fischinger the period of both the experiments in drawn sound and the Berlin lecture on the subject is identified as late summer 1932 (Moritz, "Oskar Fischinger," 33). The 1932 dating is also confirmed by the publications of Fischinger's own writings on sounding ornaments—for example, Oskar Fischinger, "Was ich mal sagen möchte," *Deutsche allgemeine Zeitung,* 23 July 1932; and the texts cited in

n. 42 above—as well as the extensive journalistic accounts that only begin to appear in the late summer and fall of 1932. See, for example, Fritz Böhme, "Verborgene Musik im Lindenblatt: Die bedeutung von Fischingers Entdeckung für den Tonfilm," *Deutsche allgemeine Zeitung,* 30 July 1932; M. Epstein, "Elektrische Musik: Neue Wege der Musikaufzeichnung," *Berliner Tageblatt,* 24 August 1932; Margot Epstein, "Gezeichnete Musik: Oskar Fischinger's 'Tönende Ornamente,'" *Allgemeine Musikzeitung,* 25 November 1932, 591; and Fritz Böhme, "Gezeichnete Musik: Betrachtungen zur Entdeckung Oskar Fischingers," *Deutsche Frauen-Kultur* 2 (February 1933): 31–33. The confusion as to the year might be due to Fischinger's highly proprietary relationship to this subject matter and his desire to show that his experiments had preceded Pfenninger's (which were also first made public in the summer of 1932)—an imperative that often led to post-factum redating of works.

44. Gustav Hegi, *Illustrierte Flora von Mittel-Europa* (Munich: J.F. Lehmann, 1906–1931).

45. Pfenninger's early animations include *Largo* (1922), *Aus dem Leben eines Hemdes* (1926), *Sonnenersatz* (1926), and *Tintenbuben* (1929). For the history of the studio, see Petra Putz, *Waterloo in Geiselgasteig: Die Geschichte des Münchner Filmkonzerns Emelka (1919–1933) im Antagonismus zwischen Bayern und dem Reich* (Trier, Germany: WVT, 1996).

46. Given how long Pfenninger would have needed to translate his initial insight into the functioning system with which he would complete his first synthetic soundtrack in 1930, it seems reasonable to assume, as numerous music and media historians have done, that Pfenninger's discovery of synthetic sound effectively took place "perhaps as early as 1929." Hugh Davies, "Drawn Sound," in *New Grove Dictionary of Musical Instruments,* vol. 1, ed. Sadie, 596–597. The 1929 date is also invoked by Peter Weibel, who states that "Rudolf Pfenninger invented 'sounding handwriting' in 1929 in Munich by taking sounds drawn onto paper strips and shooting them one by one directly with the camera, thereby incorporating them into the optical soundtrack." Weibel, "Von der visuellen Musik zum Musikvideo," in *Clip, Klapp, Bum: Von der visuellen Musik zum Musikvideo,* ed. Veruschka Body and Peter Weibel (Cologne: Dumont, 1987), 84.

47. Odo S. Matz, "Die tönende Handschrift," *Prager Deutsche Zeitung,* May 1931; reprinted in *Wahrisches Tageblatt,* 21 July 1931. See also "Töne aus dem Nichts: Die phantastische Erfindung eines Müncheners," *Telegrammzeitung,* September 1931; and "Töne aus dem Nichts: Eine Erfindung Rudolf Pfenningers," *Acht Uhr Abendblatt* (Berlin), 12 October 1931. The latter report clearly has taken Humphries's achievement as the obvious litmus test for Pfenninger's innovation when it insists that "the inventor is currently working on drawing from out of nowhere the sound curves of the human voice using a paint brush and drafting pen, based on precise physical experiments." Matz's nationalistic casting of Pfenninger's discovery is, moreover, by no means exceptional: under a widely reproduced photo of the inventor working with strips of sound waves in his studio, the *Bayerische Zeitung* of October 31, 1932, has a caption that reads, "Gemalter Tonfilm—eine bedeutsame *deutsche* Erfindung" (Painted Sound Film—A Significant *German* Invention); emphasis added.

48. Moritz, "Oskar Fischinger," 31. Moritz's account goes on to describe how "through the study of extant soundtracks he quickly mastered the calligraphy of traditional European music such that he was able to record 'Fox you have stolen the goose' and other simple melodies." In the context, this plausible but otherwise undocumented claim to have also mastered a technique that is clearly similar if not identical to Pfenninger's systematic procedure is most likely wishful apocrypha.

49. "Tonfilm ohne Tonaufnahme: Die Sensation der tönenden Schrift," *Film-Kurier,* 20 October 1932.

50. I have been able to track down reviews and/or announcements of screenings of some or all of the *Tönende Handschrift* series at the Capitol in Berlin; the Phoebus Lichtspiele and the University in Munich; the Capitol-Lichtspiele in Halberstadt; the Emelka-Theater in Münster; the Goethehaus, Imperator, and Universum-Lichtspiele in Hannover; the Kristall-Palast in Liegnitz; and the Brussels Filmweek. The film's distribution in Holland is confirmed by the existence of a print with Dutch text frames in the collection of the Nederlands Filmmuseum in Amsterdam.

51. What follows is merely a sampling of the more detailed reviews in the major European papers and film journals, leaving aside the vast number of reprints, local reviews of the various screenings, radio programs, interviews, academic lectures, and other public events promoting Pfenninger's work in the months that followed: Jury Rony, "Tonfilm ohne Tonaufnahmen," *Pressedienst der Bayerischen Film-Ges.m.b.H.* 13 (19 October 1932); Karl Kroll, "Musik aus Tinte," *Münchener Zeitung,* 19 October 1932; St., "Die tönende Handschrift," *Deutsche Filmzeitung* 43 (21 October 1932); Zz., "Tönende Handschrift," *Germania,* 21 October 1932; "Handgezeichnete Musik," *Vossische Zeitung,* 21 October 1932; "Tönende Handschrift," *Kinematograph* (Berlin), 21 October 1932; -n., "Die tönende Handschrift: Sondervorführung im Marmorhaus," *Film-Kurier,* 21 October 1932; "Pfenningers 'tönende Handschrift' im Marmorhaus," *Lichtbild-Bühne,* 21 October 1932; wkl, "Von Ruttmann bis Pfenninger: Zu der Sondervorführung in den Kammerlichtspielen," *Münchener Zeitung,* 22 October 1932; Dr. London, "Pfennigers [sic] 'tönende Handschrift,'" *Der Film,* 22 October 1932; -au-, "Gezeichnete Töne: Neue Wege für den Tonfilm," *Berliner Morgenpost,* 23 October 1932; -e., "Tönende Handschrift: Sondervorstellung im Marmorhaus," *Deutsche allgemeine Zeitung* (Beiblatt), 23 October 1932; W.P., "Der gezeichnete Tonfilm," *Frankfurter Zeitung,* 2 November 1932; "Erschließung einer unbekannten Welt: Gezeichnete Musik," *Tempo* (Berlin), 2 November 1932; and K.L., "Die tönende Handschrift," *Neue Züricher Zeitung,* 27 November 1932.

52. N., "Klänge aus dem Nichts: Rudolf Henningers [sic] 'Tönende Handschrift,'" *Film-Journal* (Berlin), 23 October 1932; K[urt] Pfister, "Die tönende Handschrift," *Breslauer Neueste Nachrichten,* 24 October 1932; -au-, "Gezeichnete Töne"; A. Huth, "Die tönende Handschrift: Eine sensationelle Erfindung," *Nordhäuser Zeitung u. Generalanzeiger,* n.d.

53. "Es klingt nach gedeckten Orgelpfeifen, nach gestopftem Horn, nach Harfe, nach Xylophon. Es klingt seltsam unwirklich." K. Wolter, "Gezeichnete Tonfilmmusik," *Filmtechnik,* 12 November 1932, 12–13. Not surprisingly, the reaction to Fischinger's experiments was much the same. According to Moritz's account, "When Fischinger picked up the first reels of *Sounding Ornaments* from the lab and had them screened there on the lab's projectors, the technicians were shocked by the strange sounds and feared that further reels with this noise could ruin their machines." "Oskar Fischinger," 33.

54. R. Prévot, "Musik aus dem Nichts: Rudolf Pfenningers 'Tönende Handschrift,'" *Münchener Neueste Nachrichten,* 20 October 1932; emphasis in original.

55. W.P., "Der gezeichnete Tonfilm."

56. wbf, "Handgezeichnete Musik," *Telegramm-Zeitung,* 19 October 1932.

57. Paul Bernhard, "Mechanik und Organik," *Der Auftakt* 10, no. 11 (1930): 239.

58. See, for example, Kroll, "Musik aus Tinte"; wkl, "Von Ruttmann bis Pfenninger"; and

"'Tönende Handschrift': Neuartige Wirkungsmöglichkeiten des Tonfilms," *Kölnische Zeitung,* 25 October 1932.

59. A[ndor] Kraszna-Krausz, "Beginning of the Year in Germany," *Close-Up* 10 (March 1933): 74–76. The comparison is cast in somewhat different terms—artistic versus commercial—in the program notes for a May 21, 1933, screening of Fischinger's "Early Experiments in Hand-Drawn Sound" at the Film Society in London. In this text, which likely was either written by Fischinger or based on materials he provided, the audience is advised that what they are about to see is "not to be confused with the similar effects invented by Hans [sic] Pfenninger. The latter system has been developed commercially to form the musical accompaniment to puppet and cartoon films." *The Film Society Programmes 1925–1939,* 277.

60. "Die Ornamente primitiver Völker sind zu untersuchen auf ihren Klangcharakter." This phrase from a typescript of Fischinger's 1932 essay "Klingende Ornamente" in the Fischinger Papers in the Iota Foundation Archive, does not appear in any of the published versions I have found.

61. "Dieses im wahrsten Sinne reinste und höchste Kunstschaffen formt ausschließlich aus einer einzigen Persönlichkeit direkt, und diese Kunstproduktion, die so entsteht, etwa Werke von Rembrandt, Bach oder Michelangelo, sind unmittelbare Schöpfungen höchster Potenz und gewinnen *gerade durch das handschriftliche,* Irrationale und Persönliche." Ingenieur Oskar Fischinger, "Der absolute Tonfilm," *Dortmunder Zeitung* (1 January 1933); emphasis added. Reprinted as "Der absolute Tonfilm: Neue Möglichkeiten für den bildenden Künstler," *Der Mittag* (Düsseldorf), January 1933; also in *Schwabischer Merkur,* 23 January 1933. A typescript of this article in the Iota Foundation Archive with the title "Der Komponist der Zukunft und der absolute Film" bears a handwritten date of 1931–1932, which might well be an example of the retro-dating mentioned earlier.

62. Fischinger's fundamentally antitechnological stance is articulated unambiguously in an essay that explains hand-drawn music as part of his project of "absolute film," which it defines as "a film that only embraces technology to the extent that it really serves to realize artistic creations. It is thus a redemption of art and of the artistic personality in the context of film production." See Böhme, "Gezeichnete Musik."

63. "Schablonen oder Drucktypen," Max Lenz, "Der gezeichnete Tonfilm," *Die Umschau* 36, no. 49 (3 December 1932): 971–973.

64. "Soundless Film Recording," *New York Times,* 29 January 1933, sec. 9, 6. As far as I can tell, no such device was ever constructed.

65. "Nach diesem Verfahren kann nur etwas hörbares durchs Mikrophon aufgenommen werden, das wirklich vorhanden ist, d.h. das irgendwo *vorher* erzeugt wurde. Rudolf Pfenninger aber schafft Töne aus dem Nichts," "Tönende Handschrift," *Völkischer Beobachter,* 25 October 1932; emphasis added.

66. "Pfenninger, schließlich, hat den Weg zur Tonschrift gefunden. Während Fischinger nun den Ton fließend photographiert, nimmt er ihn bildweise auf, was zur Fertigung von Schablonen führt, mittels deren bestimmte Töne und Tongruppen immer wiederholt werden können," Paul Seligmann, "Filmsituation 1933" in: Hirdina, ed., *Neues Bauen/Neues Gestalten*: 341; first published in *Die neue Stadt* (1932–1933), no. 10. Echoing Seligmann's conclusion, the intelligent critic of the *Münchener Zeitung* also recognized that Pfenninger's project is fundamentally different from those of his predecessors and that the credit for the invention of synthetic sound "thus

belongs entirely and exclusively to him" ("*gehört also ihm ganz allein*"). His argument however—"Rudolf Pfenninger's 'sounding handwriting' *creates* sounds from out of nowhere whereas Walter Ruttmann's, Moholy-Nagy's and Oskar Fischinger's film studies *arise out of* the music or a musical-rhythmic experience" (emphasis added)—gets the different directions of the creative vectors exactly wrong: however musical the inspiration for their genesis might have been, Fischinger's curves are not *derived* from sound; they generate it, whereas Pfenninger's curves *are* in the last analysis derived *from* the sounds that they analytically re-create. Wkl, "Von Ruttmann bis Pfenninger."

67. An intelligent, illustrated, contemporary account in English can be found in Waldemar Kaempffert, "The Week in Science," *New York Times,* 11 August 1935, sec. 10, 6.

68. This is admirably documented in the wonderful film *Theremin: An Electronic Odyssey* (Dir. Steven M. Martin, 1993).

69. "Gemalte Musik" *Pester Lloyd* (Budapest), 26 November 1932.

70. This idea nevertheless remained in circulation for quite some time. In 1936, for example, Kurt London is clearly referring to the techniques of synthetic sound when he suggests that in the future "one might do without an orchestra and instruct a composer to put his music together in patterns upon paper, which would then be photographed and then produce a very strange and quite unusual sound." London, *Film Music* (London: Faber & Faber, 1936), 197.

71. A striking example of the dramatic new possibilities of acoustic montage afforded by the Tri-Ergon system is Walter Ruttmann's eleven-minute and ten second image-less "film" entitled "Weekend." Ruttmann's sonic collage, which took full advantage of the ability to edit sounds made possible by recording on the optical film sound track (instead of the gramophone), was broadcast on Berlin radio on 13 June 1930 and, after decades during which it was considered lost, was rediscovered in New York in 1978. It is readily available, together with a series of contemporary "remixes" by John Oswald, to rococo rot and others, on an Intermedium label CD (Rec 003).

72. Lac., "Erschließung einer unbekannten Welt: Gezeichnete Musik," *Tempo* (Berlin), 2 November 1932.

73. ky., "Die tönende Schrift: Eine Umwälzung auf dem Gebiete der Tonwiedergabe," *Kölner Tageblatt,* 18 November 1932; reprint in *Solinger Tageblatt,* 3 December 1932.

74. Herbert Rosen, "Die tönende Handschrift," *Die grüne Post* 24 (11 June 1933): 14.

75. "Die Zeit war noch nicht reif; meine Erfindung kam 20 Jahre zu früh," Hans Rolf Strobel, "Musik mit Bleistift und Tusche: Der Filmklub zeigt heute Rudolf Pfenningers Kurzfilme," Münchener *Abendzeitung,* 4 May 1953.

76. Despite this negative assessment, Pfenninger was able to stay in Germany both during and after the Third Reich, working as a production and set designer in the Geiselgasteig film studios outside Munich, where his credits included animation work on *Wasser für Canitoga* (Dir. Herbert Selpin, 1939), set design for *Das sündige Dorf* (Dir. Joe Stöckel, 1940) and for *Hauptsache Glücklich!* (Dir. Theo Lingen, 1941), production design for *Einmal der liebe Herrgott sein* (Dir. Hans H. Zerlett, 1942) and for *Orient Express* (Dir. Viktor Tourjansky, 1944), set design for *Der Brandner Kasper schaut ins Paradies* (Dir. Josef von Baky, 1949), *Das seltsame Leben des Herrn Bruggs* (Dir. Erich Engel, 1951), and *Nachts auf den Straßen* (Dir. Rudolf Jugert, 1952) as well as production design for *Aufruhr im Paradies* (Dir. Joe Stöckel, 1950).

77. Years later Moholy-Nagy recalled that the sound track for *Tönendes ABC* "used all types of

signs, symbols, even the letters of the alphabet, and my own finger prints. Each visual pattern on the sound track produced a sound which had the character of whistling and other noises. I had especially good results with the profiles of persons." Moholy-Nagy, *Vision in Motion* (Chicago: Paul Theobald, 1947), 277. Unfortunately, there is no way to examine more carefully what appears to be the rather surprisingly Fischingerian character of this film, because, while it was shown at the London Film Society on December 10, 1933, it is now lost.

78. Moritz documents in great detail the fascinating and, of course, ultimately futile attempts by Fischinger and his supporters well into the mid-1930s to convince the fundamentally anti-modernist National Socialist regime of the great cultural value of the genre of "absolute film." Moritz, "Oskar Fischinger," 35–45. Fischinger even went so far as to write a letter to Goebbels in December 1935 demanding both respect and financial support for his films. However, thanks to Ernst Lubitsch, by February 1936 Fischinger and his films were on their way to Hollywood to take up a job at Paramount. It was here that he worked on the "Toccata and Fugue in D Major" sequence of Disney's *Fantasia* directed by Samuel Armstrong (1940).

79. Arthur Knight, *The Liveliest Art* (New York: MacMillan: 1957), 158.

80. See, for example, P.W., "Les sons synthétiques de l'ingénieur Pfenninger," *XXme Siecle* (Brussels), 16 December 1932; and "Curieuse expérience," *Musique et instruments,* 285 (1933): 265.

81. See Arthur Hoérée and Arthur Honegger, "Particularités sonores du film *Rapt,*" *La Revue musicale* 15 (1934): 90; and Arthur Hoérée, "Le Travail du film sonore," *La Revue musicale* 15 (1934): 72–73. For a more general context of the reception and development of synthetic sound in France, see Richard Schmidt James, *Expansion of Sound Resources in France, 1913–1940, and Its Relationship to Electronic Music* (Ph.D. diss., University of Michigan, 1981).

82. See, for example, the extended discussion of Pfenninger in a lengthy article by Luciano Bonacossa, "Disegni animati e musica sintetica," *La vie d'Italia* 40, no. 8 (August 1934): 571–582, esp. 578–582.

83. Herbert Rosen, "Synthetic Sound: Voices from Pencil Strokes," *Wireless World* (London), 3 February 1933, 101; and Paul Popper, "Synthetic Sound: How Sound Is Produced on the Drawing Board," *Sight and Sound* 2, no. 7 (Autumn 1933): 82–84. Only a few years later *Sight and Sound* published a more general account by V. Solev entitled "Absolute Music," *Sight and Sound* 5, no. 18 (Summer 1936): 48–50; an earlier version of this article had appeared as "Absolute Music by Designed Sound," *American Cinematographer* 17, no. 4 (April 1936): 146–148, 154–155.

84. Program note, *The Film Society* (London), 13 January 1935; reprinted in *The Film Society Programmes,* 310.

85. Interview with McLaren in Maynard Collins, *Norman McLaren* (Ottawa: Canadian Film Institute, 1976), 73–74.

86. Besides the early essay he authored with Robert E. Lewis entitled "Synthetic Sound on Film," *Journal of the Society of Motion Picture Engineers* 50, no. 3 (March 1948), 233–247, McLaren wrote "Animated Sound on Film," a pamphlet first published by the National Film Board of Canada in 1950 and then in a revised version as "Notes on Animated Sound," *Quarterly of Film, Radio and Television* 7, no. 3 (1953): 223–229. This text was subsequently reprinted in Roger Manvell and John Huntley, *The Technique of Film Music* (1959; revised and reprinted, New York: Focal Press, 1975), 185–193; excerpted in Russett and Starr, eds., *Experimental Animation,* 166–168; and reprinted almost without acknowledgment in Roy M. Prendergrast, *Film Music: A*

Neglected Art (1977; reprint, New York: W.W. Norton, 1992), 186–193. See also Valliere T. Richard, *Norman McLaren, Manipulator of Movement. The National Film Board Years, 1947–1967* (Newark: University of Delaware Press, 1982).

87. David Wilson, "Synchromy," *Monthly Film Bulletin* 39, no. 466 (November 1972): 241.

88. See John Whitney and James Whitney, "Audio-Visual Music," in *Art in Cinema,* ed. Frank Stauffacher, 31–34 (San Francisco: SF-MOMA, 1947; reprint, New York: Arno Press, 1970); reprinted in P. Adams Sitney, ed., *The Avant-Garde Film: A Reader of Theory and Criticism* (New York: New York University Press, 1978), 83–86. John Whitney and James Whitney, "Notes on the 'Five Abstract Film Exercises,'" in *Art in Cinema,* ed. Stauffacher. John Whitney, "Bewegungsbilder und elektronische Musik," trans. Ruth Cardew, in *Die Reihe: Information über serielle Musik* 7 (1960): 62–73; in English as "Moving Pictures and Electronic Music," *Die Reihe* (English ed.) 7 (1965): 61; reprinted in Russett and Starr, eds., *Experimental Animation,* 171–173. On Kren, see Hans Scheugl, ed., *Ex Underground Kurt Kren* (Vienna: PVS, 1996), esp. 161. See also Barry Spinello, "Notes on 'Soundtrack,'" in *Experimental Animation,* ed. Russett and Starr, 175–176; first published in *Source: Music of the Avant Garde* 6 (1970).

89. Lev Manovich, "What Is Digital Cinema?" in *The Digital Dialectic: New Essays on New Media,* ed. Peter Lunenfeld, 173–192 (Cambridge: MIT Press, 1999), 175.