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Encoding Music: Perforated Paper, Copyright Law, and the Legibility of Code, 1880–1908

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ENCODING MUSIC:
PERFORATED PAPER, COPYRIGHT
LAW, AND THE LEGIBILITY OF CODE,
1880–1908

Gerardo Con Díaz[†]

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INTRODUCTION

The copyrightability of object code—the strings of zeroes and ones that allow a computer to execute instructions—is not very controversial anymore, even though most people cannot read it.¹ The U.S. Copyright Office’s guidelines on the registration of computer programs state that while the Office “strongly prefers” deposits of source code (which normally involves more familiar words, symbols, and syntax), applicants can opt to submit object code instead. The Office would then issue a registration under its Rule of Doubt policy, which resolves uncertain cases in the applicant’s favor without granting a presumption

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1. See GERARDO CON DÍAZ, SOFTWARE RIGHTS: HOW PATENT LAW TRANSFORMED SOFTWARE DEVELOPMENT IN AMERICA 122–229 (2019).

of validity.² This practice has been in place for decades, and it is a byproduct of a century-old struggle to determine how the U.S. Copyright system should deal with works that are very difficult, if not entirely impossible, for human beings to read without any mechanical or electronic aides.³

The Copyright Office today relies on applicants' ability to read and assess the originality of their own object code. Specifically, applicants must "state in writing that the object code contains copyrightable authorship," and the Office accepts these statements at face value. For instance, if I were applying for an object code registration, I would include that statement and highlight the following code:

```
0100001101101111011100000111100101110010011010010110011101101  
0000111010000100000110000101010100100100000001100100011000000  
1100100011000100100000011000100111100100100000010001110110010  
1011100100110000101110010011001000110111100100000010000110110  
1111011011100010000001000100110000111010110101100001011110100  
0101110
```

I would also submit a note saying that this text reads, "Copyright © 2021 by Gerardo Con Díaz." This would satisfy the registration requirement of highlighting the portion of object code that corresponds to a copyright notice and presenting it "in words and numbers that an examiner can read."⁴ However, the binary string above is not necessarily illegible. It is written in an industry standard language called ASCII (American Standard Code for Information Interchange). Reading from left to right, each 8-digit-long string, called a byte, corresponds to a letter; the copyright sign, ©, is a special character that consists of two bytes.⁵ A person fluent in ASCII, perhaps a very diligent

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2. U.S. COPYRIGHT OFFICE, COPYRIGHT REGISTRATION OF COMPUTER PROGRAMS 6 (2021).
 3. There is, of course, a history of machine-readability in copyright law. Machine-readability is woven into the main analysis in this article, but I am primarily concerned with the legal construction of "reading" as a human activity at the turn of the twentieth century and the efforts to delineate how much intellectual labor this task can involve before courts deem a text illegible. Unless otherwise indicated, my use of the terms "legible" and "illegible" refers to this human activity. For more on machine-readable works, see CON DÍAZ, *supra* note 1, 122–138.
 4. U.S. COPYRIGHT OFFICE, *supra* note 2, at 6.
 5. If a person knows that this code is written in ASCII, they could follow this procedure: first, reading from left to right, divide the string into bytes. Second, determine the letter that corresponds to each byte, using ASCII's translation table if necessary. Adding a space after each byte could make it unnecessary to tell the reader that the code is written in ASCII. For instance, a single space after the first byte would yield the text "01000011 01101111," which a person fluent in ASCII would easily recognize as

computer engineer, would be able to read the text, even if it may take them a few minutes depending on their skill level.⁶

This does not matter at the Copyright Office, which would deem the string illegible even though a person who has basic familiarity with ASCII would be able to translate it. The financial and logistical benefits of this practice are clear; it would be very burdensome for examiners to translate every program they encounter in object code, even if they had automatic translators like the ones freely available on the Internet.⁷ At the same time, this practice also offers a bureaucratic solution for a much deeper problem with which the U.S. copyright system has been grappling since the 19th century: many of the creative works that copyright law is meant to protect—including all musical compositions, literary works, and software—can be fully inscribed, reproduced, and transmitted through an infinite variety of binary codes, each one legible only to people familiar with its rules and structure.⁸

This article examines the legibility of binary code in U.S. copyright through a case study of *White-Smith v. Apollo* (1908), a landmark Supreme Court opinion on the copyright-eligibility of punched rolls for player pianos (which encode music into binary code through the perforation of paper rolls). The *White-Smith* Court unanimously ruled that the Apollo Company, a distributor of punched rolls for automatic piano players, did not have to pay royalties to a music sheet publisher (White-Smith) because copyright protection does not extend to mechanical parts.⁹ The fact that the rolls caused a piano to perform a composer's song was irrelevant in this logic because their status as machine components (which the Court justified by pointing out that human beings couldn't read them) precluded them from qualifying as writings for the purposes of copyright law.¹⁰ The 1909 Copyright Act would overturn much of this reasoning by establishing that the creator of a musical composition has exclusive rights over any mechanical

corresponding to the syllable "Co." A table for ASCII translation is found here: https://en.wikipedia.org/wiki/ASCII#/media/File:USASCII_code_chart.png [<https://perma.cc/9FLX-DDAL>].

6. Reading the code would therefore involve an intermediate translational step if the reader is not fluent in ASCII. This also occurs in other contexts, such as learning how to read sight-read music (which may involve the intermediate step of translating the score into the corresponding note sequence) or reading in a new language (which may involve translating words individually before stringing them together into a sentence).
7. A simple converter is available at <http://www.unit-conversion.info/texttools/convert-text-to-binary/>.
8. The mathematics of binary representation make the variety of codes infinite, though of course only a finite number of these are in use.
9. *White-Smith Music Publ'g Co. v. Apollo Co.*, 209 U.S. 1, 8, 18 (1908).
10. *Id.* at 7, 18.

reproductions of the work, including punched rolls.¹¹ However, even despite this statutory change, *White-Smith's* emphasis on human legibility as a precondition for the authorship of a writing allowed vestiges of the print-based conceptions of copyright to shape U.S. law and innovation for decades to come.¹²

All this unfolded at a time when courts were reconsidering foundational assumptions about what copyright is and what it is meant to protect.¹³ U.S. copyright law at the time was grounded primarily on its late eighteenth-century origins as a means of regulating the book trade by protecting print materials from unauthorized reprinting. Court opinions and legal scholarship in the early nineteenth century revolved tightly around a print-based notion of the “copy”—a legal construct that Oren Bracha characterized as “a semi-materialist object of ownership, at once intangible and endowed with qualities equivalent to those of owned physical objects.”¹⁴ For example, novelists could claim copyright over a book, but not its translations.¹⁵ Composers could claim copyrights over the sheet music for their songs, but that didn't give them the right to exclude others from playing the song at a public square or writing down the song in an alternative musical notation and distributing it that way. Conceptions of the “copy” began to expand in the second half of the nineteenth century, as the relentless economic and ideological pressures of corporate liberalism pushed the U.S. Congress and courts to include a broader swath of commercial uses, including translations and dramatizations (1870) and public performances of music (1897).¹⁶ These shifting landscapes of copyright doctrine, along with a growing impulse to mass produce creative works

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11. Copyright Act of 1909, Pub. L. No. 60-349, 35 Stat. 1075 (repealed 1976).
 12. See, e.g., *Data Cash Sys., Inc. v. JS&A Grp., Inc.*, 480 F. Supp. 1063, 1065, 1069 (N.D. Ill. 1979) (denying copyright protection to object code on the grounds that it is not a “writing” or “copy”), *aff'd*, 628 F.2d 1038 (7th Cir. 1980); *Apple Comput., Inc. v. Franklin Comput. Corp.*, 714 F.2d 1240, 1254 (3d Cir. 1983) (reversing similar reasoning by the district court, and holding a computer program's source code to be a copyrightable work).
 13. This paragraph is based on BRACHA, *infra* note 14. More generally, in the late nineteenth century, courts were concerned with conceptualizing the distinctions behind dualities such as inventions versus creative works, authorship versus invention, patents versus copyrights, and so on. See Pamela Samuelson, *The Story of Baker v. Selden: Sharpening the Distinction Between Authorship and Invention*, in *INTELLECTUAL PROPERTY STORIES* 159 (Jane C. Ginsburg & Rochelle Cooper Dreyfuss eds., 2006).
 14. OREN BRACHA, *OWNING IDEAS: THE INTELLECTUAL ORIGINS OF AMERICAN INTELLECTUAL PROPERTY, 1790–1909*, at 6–7 (2016).
 15. *Stowe v. Thomas*, 23 F. Cas. 201 (1853) (No. 13,513). The rest of this paragraph is based on BRACHA, *supra* note 14.
 16. BRACHA, *supra* note 14, at 176–77.

and industrial pressures protect copyright owners from a broad range of unauthorized commercial uses of their works, set the stage for the battle between White-Smith and Apollo. The commercial stakes were very high: had the Court ruled in White-Smith's favor, then a large multinational corporation called the Aeolian Company would have likely been able to leverage control over the punched roll industry to expand and perpetuate its dominance over the market for automatic player pianos.

The story of *White-Smith v. Apollo* brings together the business history of the U.S. music industry and the technical history of an immensely versatile invention: surfaces (especially paper) with holes on them.¹⁷ I argue that *White-Smith* was a strategic attempt to resolve the long-term conceptual and sociotechnical tensions born from three simultaneous processes in the history of perforated surfaces in the long nineteenth century: their technological development as storage media, their industrial emergence as mass manufactures, and their commercial transformation into a product that could enable and perpetuate market dominance in the automatic player industry. At the Supreme Court, this effort yielded a framework for copyright eligibility that placed legibility as an essential characteristic of a writing, and which allowed text-based conceptions of the "copy" to influence U.S. copyright law well into the 1980s.¹⁸

This argument consists of four parts. The first offers an overview of the business history of U.S. music in the late nineteenth century, recounting how its explosive growth propelled the creation and early development of new markets for the mass manufacturing of music

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17. Methodologically, I place these surfaces in their broader commercial and technological landscapes to identify logical, technical, and representational continuities in the legal and business histories of binary coding. This approach invites inquiry into the history of music to investigate the political economy of code. It also underscores the value of approaching the legal history of coding through flexible analytical frameworks for media studies such as Lisa Gitelman's, which conceptualizes media as "socially realized structures of communication" that include "both technological forms and their associated protocols." LISA GITELMAN, *ALWAYS ALREADY NEW: MEDIA, HISTORY, AND THE DATA OF CULTURE* 7 (2006) [hereinafter Gitelman, *ALWAYS ALREADY NEW*]; see also, Lisa Gitelman, *Media, Materiality, and the Measure of the Digital; Or, the Case of Sheet Music and the Problem of Piano Rolls*, in *MEMORY BYTES: HISTORY, TECHNOLOGY, AND DIGITAL CULTURE* 199–217 (Lauren Rabinovitz and Abraham Geil eds., 2004) [hereinafter Gitelman, *Media, Materiality, and the Measure of the Digital*]; LISA GITELMAN, *PAPER KNOWLEDGE: TOWARD A MEDIA HISTORY OF DOCUMENTS* (2014) [hereinafter GITELMAN, *PAPER KNOWLEDGE*].
18. See, e.g., *Apple Comput., Inc. v. Franklin Comput. Corp.*, 714 F.2d 1240, 1248 (3d Cir. 1983) (discussing the Supreme Court's requirement of human readability for copyright protection, but suggesting the 1976 Copyright Act was "intended to obliterate" this distinction).

sheets and perforated rolls. The second examines the technical history of perforated surfaces to emphasize that a mechanical conception of punched rolls was made possible by a series of inventions that simultaneously embraced and concealed the rolls' potential to be used as an alternative to traditional musical notations. The third highlights early efforts, in England and the United States, to identify the copyright implications of the materiality and uses of perforated surfaces. The final section recounts a key episode from the history of *White-Smith* to show how music scholars at the time tried, and failed, to decipher melodies from these rolls—that is, to read the rolls.

I. MANUFACTURING MUSIC

The American music industry underwent a series of extraordinary transformations in the late nineteenth century. Pianos and other keyboard instruments had become a centerpiece of middle-class homes, and nurturing a musical life was as much a family activity as it was a sign of social and financial stability. The music played on home pianos, however, was not necessarily drawn from the classical composers whose work might have dominated high-end performance spaces. Vaudeville and blackface minstrelsy were steadily rising in popularity.¹⁹ White composers and publishers incessantly exploited Black people's lives and cultures, mocking them through simple tunes written for the entertainment of white families.²⁰ Anti-Black racism was rampant in this new, more industrialized music industry. It was perpetuated by publishers' efforts to move away from the traditional model for music publishing—wherein a firm invested heavily in recruiting top composers and marketing their work—and towards a model that relied on publishing as many songs as possible in hopes that one of them would become a hit.²¹ Most songs would cause financial losses, but a small group of popular songs could generate enough revenue for publishers to turn a healthy profit.²²

19. 2 RUSSELL SANJEK, *AMERICAN POPULAR MUSIC AND ITS BUSINESS: THE FIRST HUNDRED YEARS: FROM 1790 TO 1909*, at 269–297 (1988).

20. Stephanie Dunson, *The Minstrel in the Parlor: Nineteenth-Century Sheet Music and the Domestication of Blackface Minstrelsy*, 16 *ATQ: 19TH CENTURY AM. LITERATURE & CULTURE*, no. 4, 2002, at 241–256. For a British perspective on this phenomenon, see John Mullen, *Anti-Black Racism in British Popular Music (1880-1920)*, XVII *REVUE FRANÇAISE DE CIVILISATION BRITANNIQUE*, no. 2, 2012, at 61–80; *see also* DEREK B. SCOTT, *SOUNDS OF THE METROPOLIS: THE 19TH CENTURY POPULAR MUSIC REVOLUTION IN LONDON, NEW YORK, PARIS AND VIENNA* (2008).

21. *See* DAVID SUISMAN, *SELLING SOUNDS: THE COMMERCIAL REVOLUTION IN AMERICAN MUSIC* 25 (2012) (explaining the “commercial turn in music publishing” and publishers’ “unprecedented aggressiveness”).

22. *Id.* at 22–23.

In this changing commercial environment, the music industry's growth drew on the mass manufacturing impulse that characterized the late 1880s.²³ Much of this growth took place in New York City, where a collection of publishers known as Tin Pan Alley started to rely less on aesthetic innovation than on the ability to recruit large numbers of composers and ask each of them to write as many songs as possible.²⁴ These composers would create original songs while following whatever trends seemed most promising to them or their employers.²⁵ If a certain song started to sell very well, they would study it and others like it, mimic their chord progressions and melodic patterns, and create new, but similar, songs.²⁶ This allowed composers to make a living—a recent possibility born from the music industry's new production model—but it also changed their status from artists to workers in a fast-paced and distinctly capitalist manufacturing system. As a result, as one scholar has noted, “many songwriters plainly understood their products as artificial constructions and their labor as a form of professional manufacturing.”²⁷

This commercial and cultural transformation in the U.S. music industry unfolded jointly with a broad-ranging technological one. Phonographs are perhaps the best-known nineteenth century technological novelty in sound recording and production, but at first they were used primarily to record spoken voice, and there was no real domestic market for them as home technologies.²⁸ The newest technologies to transform the U.S. music industry were, instead, automatic music players. There was an enormous diversity of devices of this kind, ranging in size from hand-held instruments to heavy

23. See CATHERINE L. FISK, *WORKING KNOWLEDGE: EMPLOYEE INNOVATION AND THE RISE OF CORPORATE INTELLECTUAL PROPERTY, 1800–1930* (2009) (describing general changes in American commercialism during this time period); THOMAS P. HUGHES, *AMERICAN GENESIS: A CENTURY OF INVENTION AND TECHNOLOGICAL ENTHUSIASM, 1870–1970* (1989) (discussing technological advances at this time); ALAIN POTTAGE & BRAD SHERMAN, *FIGURES OF INVENTION: A HISTORY OF MODERN PATENT LAW* (2010) (discussing changes to the patent system as a result of this industrialization).

24. SANJEK, *supra* note 19, at 346–401.

25. SUISMAN, *supra* note 21, at 20–44.

26. See *id.* at 41 (explaining that regardless of “how catchy or clever individual songs were, the business from which they issued rested on rational calculation to yield standardized products and to reduce uncertainty and fluctuation in supply and demand”).

27. *Id.* at 45.

28. *Id.* at 95–101.

contraptions that users could install over master pianos.²⁹ Automatic music players had been available for centuries; by positioning pins on a rotating surface, inventors around the world had been able to create systems such as music boxes and automatic bell players.³⁰ However, the newest generation of automatic players allowed users to experience the sounds of pianos and organs of all sizes.³¹ Paired with the mass production model for songwriting that publishers were adopting, these new devices fundamentally revolutionized home entertainment in the United States by allowing users to acquire music at a low cost and enjoy it without needing any musical training.³²

By far the largest company in the automatic player industry was the Aeolian Company. Founded in 1887 by a piano maker named William B. Tremaine, Aeolian manufactured automatic players for use with pianos and organs.³³ Rather than starting a new company from scratch, Tremaine had orchestrated the merger between two growing companies: the Automatic Music Paper Company in Boston, and the Mechanical Organette Company in New York.³⁴ This meant that, from the get-go, Aeolian was armed with both the technical know-how required to manufacture automatic instruments, and with the facilities and patents needed to create high volumes of paper rolls.

29. ANDRE MILLARD, *AMERICA ON RECORD: A HISTORY OF RECORDED SOUND* 44, 119–21 (2d ed. 2005).

30. SUISMAN, *supra* note 21, at 92.

31. *See id.* at 91 (explaining how mechanical reproduction placed music in “inexpensive, fungible, durable objects”).

32. *See id.* at 90–93.

33. *Id.* at 96.

34. *Id.*

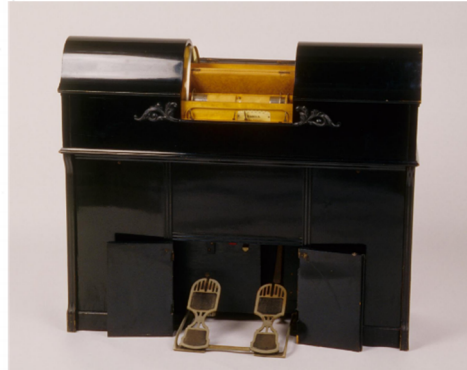
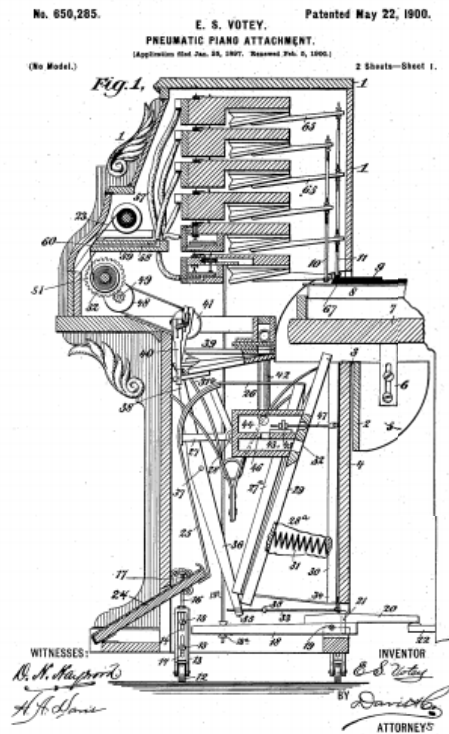


Figure 1. The image on the left-hand side is a schematic representation of the inside of a Pianola. Rolls are loaded at the top, left. Edwin Votey, Pneumatic Piano Attachment, U.S. Patent 650,285 (issued May 22, 1900). The image on the right-hand side is an external view of the same kind of device. Note the two pedals at the bottom, which allow users to modify playback speed. Courtesy of the Division of Cultural and Community Life, National Museum of American History, Smithsonian Institution.

However, unlike the automatic pianos of the twentieth century, where a motorized system was installed inside the instruments themselves, Aeolian's early models were large devices that could be mounted on the front of the piano.³⁵ The most popular model, called the Pianola (Figure 1) was a large wooden box as wide as a grand piano, and a few inches taller than the height of the piano's keys. On the front

35. See Canada Science and Technology Museum, *1905 Aeolian Pianola piano player*, YOUTUBE (May 8, 2012), <https://www.youtube.com/watch?v=gfo6z74qbd8/> [https://perma.cc/659T-Z34G] (demonstrating how the Aeolian pianola works).

of the box were two pedals that the user would pump to power the device and adjust the tempo of the playback. Behind this front panel, just above the piano's keyboard, was a collection of wooden fingers, one for each of the keys. These fingers would press down on the keys in accordance with the operation of a pneumatic system at the top of the Pianola. True to the company's name, this device was entirely dependent on the movement of air: a perforated paper roll would slide over a series of valves arranged horizontally, one for each wooden finger. When a perforation passed over the valve, air would be pumped through the valve, into the Pianola, and towards a finger, which would press the corresponding piano key.³⁶

This is all to say that early player pianos were not fully automatic devices that a person could just turn on and leave alone. These machines were human-powered, and users were able to control their operation by changing the speed at which they pumped the pedals.³⁷ This meant that the rolls themselves could contain information beyond the sequence of perforations that allowed the machine to operate its wooden fingers. Manufacturers sometimes printed words and symbols on the roll to aid users in their performance—information such as the song's tempo and, for more advanced models, the volume changes throughout.³⁸ Often conveyed through standard musical symbols that composers had added to music sheets, these markings provided the operator with a suggested performative roadmap to get through the song. Later models would even include the songs' lyrics alongside the perforations, so that people could gather around the automatic player and sing along.³⁹

Harry B. Tremaine, William's son, led a global expansion of the Aeolian company designed to transform Pianolas into the player piano standard around the world.⁴⁰ Drawn to the aggressive strategic and structural maneuvering that characterized industrial growth at the time, Harry spearheaded an international expansion that generated Aeolian subsidiaries from England to Australia.⁴¹ Capitalized at ten

36. SUISMAN, *supra* note 21, at 93.

37. *Id.*

38. *Id.* at 99.

39. *Australian-Made Piano Rolls—a Generous Donation to Rare Music*, UNIV. OF MELBOURNE, <https://blogs.unimelb.edu.au/librarycollections/2016/11/15/australian-made-piano-rolls-a-generous-donation-to-rare-music/> [<https://perma.cc/ER6C-8V8R>].

40. SUISMAN, *supra* note 21, at 96.

41. *See id.* This was not unique to the music industry. *See* ALFRED D. CHANDLER, JR., *STRATEGY AND STRUCTURE: CHAPTERS IN THE HISTORY OF AMERICAN ENTERPRISE* 114, 163 (1962) (noting that companies such

million dollars, the company relied heavily on aggressive advertising campaigns in its efforts to grow. These ads boasted the Aeolian instruments' popularity among some of the most prominent people in Europe and the Americas, from the Queen of England and the President of Mexico, to the Pope and some of the best-known industrial magnates and artists.⁴² By the early 1900s, a series of mergers and acquisitions, paired with partnerships with prominent piano brands such as Steinway & Sons, helped to establish Aeolian as the most powerful firm in the automatic player industry—one that professed to complement the traditional piano industry rather than replace it, allowing new and easier ways of enjoying music in the highest social circles.⁴³

For player pianos to work, though, Aeolian needed rolls. The company had its own punched roll factories, but it also allowed smaller firms to manufacture rolls for it.⁴⁴ Like Aeolian itself, these smaller firms did not have the custom of paying any royalties or fees to the composers of the songs that they used.⁴⁵ This was a departure from the standard practice among manufacturers of smaller automatic instruments, discussed later in this essay, who did pay royalties to publishers and composers. Aeolian favored not paying, of course, because the availability of large catalogues of low-cost rolls would make their automatic pianos more desirable. At the same time, rising sales of sheet music discouraged music publishers from actively opposing this arrangement.⁴⁶ In fact, music publishers sometimes requested roll manufacturers to make rolls based on their sheets, asking for no royalties in return.⁴⁷ The publishers' reasoning was that automatic pianos, especially those placed in public venues, would increase their songs' popularity and lead to further demand for their sheet music.⁴⁸

By the century's end, the player piano industry started exhibiting some signs of fierce competition. Tremaine's main competitor was Melville Clark, a New York piano tuner who had entered the instrument-making business by creating an organ factory in California.⁴⁹ Like many other aspiring manufacturers in the 1890s, Clark pursued a

as General Motors and the Standard Oil Company engaged in strategic and structural maneuvering).

42. SUISMAN, *supra* note 21, at 97.

43. *Id.* at 98.

44. GARY A. ROSEN, *ADVENTURES OF A JAZZ AGE LAWYER: NATHAN BURKAN AND THE MAKING OF AMERICAN POPULAR CULTURE* 47 (2020).

45. *Id.*

46. *Id.* at 48.

47. *Id.*

48. *Id.*

49. *Id.* at 47.

merger-based growth strategy that culminated with the creation of the Story and Clark Piano & Organ Company in 1895.⁵⁰ In 1900, as this company expanded to include the European market, Clark became fascinated with player pianos and started a new company, the Melville Clark Piano Company.⁵¹ He also created a punched roll firm called QRS music rolls. This firm still exists today, but at the time it manufactured the large volumes of rolls required to operate Clark's main product: an automatic player called the Apollo, with which he hoped to compete directly with Aeolian.⁵²

In this context, rolls had immense strategic value because control over their market could yield control over the market for player pianos. Aeolian and Melville Clark had extensive patent portfolios for the players themselves and for some roll-related technology, but efforts to control the industry through patent wars had not been very successful for either of them.⁵³ The rolls, however, were a low-cost medium made by a burgeoning sub-industry with low barriers to entry and a seemingly endless catalog of goods. Their supply and demand were inseparable from the market dynamics of the player piano industry itself. A player piano for which no punched rolls were available would, effectively, be an expensive mechanical contraption that would do little more than block access to the keys. Conversely, the availability of a very large catalog of punched rolls could potentially make a specific brand of automatic pianos more desirable than its competitors. This meant that a company could potentially secure a larger market share in the player piano industry not by reducing its prices or offering technically superior products, but instead by tilting the punched roll industry in its favor.

This situation encouraged Harry Tremaine to pursue a roll-centered strategy for market dominance. His company's lawyers approached the members of the Music Publishers Association—the primary trade association for sheet music publishers, with over eighty members—with a seemingly irresistible deal.⁵⁴ Aeolian's two agreements with the Clayton Summy Company, a music publisher in Chicago, were typical in these arrangements. In the first one, Summy granted Aeolian

50. This was, of course, not unusual at the time. See NAOMI R. LAMOREAUX, *THE GREAT MERGER MOVEMENT IN AMERICAN BUSINESS, 1895–1904*, at 1 (1988).

51. ROSEN, *supra* note 44, at 47.

52. *Id.*

53. See Edward M. Cramer, *Some Observations on the Copyright Law of 1976: Not Everything is Beautiful*, 1 HASTINGS COMM'NS. & ENT. L.J. 157, 159 n.15 (1977).

54. Petition of the Connorized Music Co. for Permission to File a Brief, & Also to Make an Oral Argument, on the Side of the Appellee at c, White-Smith Music Publ'g Co. v. Apollo Co., 209 U.S. 1 (1908) (Nos. 110, 111) [hereinafter Petition of the Connorized Music Co.].

exclusive rights to create “perforated music sheets” for use in automatic keyboard musical instruments.⁵⁵ In return, Aeolian agreed to pay royalties amounting to ten percent of the list price or fifty cents per roll, whichever one was lower.⁵⁶ In the second agreement, both companies established that this royalty arrangement was contingent on two developments.⁵⁷ First, Aeolian would launch, and cover the costs of, a lawsuit “against some manufacturer or user” to test the applicability of copyright laws to perforated rolls.⁵⁸ An opinion by the “court of last resort” establishing the applicability of copyright laws to perforated rolls would be the first requisite development.⁵⁹ The second development was for Aeolian’s executives to decide that enough publishing companies had agreed to the same terms.⁶⁰

Aeolian’s arrangements across the punched roll industry threatened to squeeze out smaller roll manufacturers who did not agree to its terms. Consider the Connorized Music Company, a Bronx-based manufacturer created by James O’Connor, an inventor who in 1900 had secured a key patent for automatic keyboard players and the punched rolls needed to operate them.⁶¹ Connorized Music conducted its business primarily by establishing contracts with the manufacturers of automatic musical instruments.⁶² Each of those contracts included a license that allowed the manufacturers to make and sell O’Connor’s patented rolls.⁶³ For this reason, O’Connor and his attorneys saw Aeolian as a large and wealthy corporation eager to dominate the automatic player industry at the expense of firms like their own.⁶⁴ If Aeolian’s contracts became valid, then most of the members of the Music Publishers’ Association, perhaps even all of them, would find themselves unable to grant manufacturing contracts to anyone other than Aeolian itself. In effect,

55. Defendant’s Exhibit Aeolian-Summy Contract.—Document No. 1, Transcript of Record at 520, *White-Smith Music Publ’g Co.*, 209 U.S. 1 (Nos. 110, 111) [hereinafter Defendant’s Exhibit No. 1].

56. *Id.*

57. Defendant’s Exhibit Aeolian-Summy Contract.—Document No. 2, Transcript of Record at 521, *White-Smith Music Publ’g Co.*, 209 U.S. 1 (Nos. 110, 111) [hereinafter Defendant’s Exhibit No. 2]. *See also* ROSEN, *supra* note 44, at 48.

58. Defendant’s Exhibit No. 2, *supra* note 57.

59. *Id.*

60. *Id.*

61. Self-Playing Musical Instrument, U.S. Patent No. 661,920 (issued Nov. 13, 1900).

62. Petition of the Connorized Music Co., *supra* note 54, at b.

63. *Id.* at b–c.

64. *Id.* at c–d.

this could result in Aeolian being granted a monopoly in the punched roll industry and, by extension, the automatic instrument industry itself.⁶⁵

Over the coming years, according to an attorney close to the case, Aeolian “poured out money like water” into its effort to secure copyright protection for the rolls by orchestrating a lawsuit.⁶⁶ One of the charter members of the Music Publishers’ Association, the White-Smith Music Publishing Company of Boston, became the plaintiff for the case.⁶⁷ The defendant was the Apollo Company, which distributed players and rolls produced by the Melville Clark Company.⁶⁸ In this arrangement, White-Smith was a passive stand-in for Aeolian. If the case turned out in Aeolian’s favor, then White-Smith would start receiving royalty checks; otherwise, their relationship would remain unchanged. However, Aeolian’s legal battle over the next few years, which would culminate at the Supreme Court, hinged on a difficult problem: arguing that the reproduction of a roll of punched paper—effectively, the manufacturing of what could easily be construed as an industrial good—amounted to creating a copy of the song for the purposes of copyright law. This required finding a way to engage with perforated paper simultaneously as a storage medium, a mass manufactured technology, and a potentially legible fixation of a composer’s creativity.

II. THE INFINITE POTENTIAL OF PERFORATED PAPER

The rolls that enable player pianos to work belong to the longer history of how inventors in the nineteenth century used holes on a range of surfaces (paper scrolls, discrete cards, interconnected metal plates, and so on) to control the operation of a machine. This history includes looms, automatic instruments, and tabulating equipment. These perforation-based systems had several recurring technical features: the reduction of complex, potentially infinite problems into discrete binary operations; reliance on a grid to organize the perforations; and the need for a mechanical device that forced objects or air through the perforations in order to cause the machine to operate. However, despite the physical similarities among all surfaces of this kind, their structures and visual layouts depended on whether they were intended to replicate

65. *Id.* at d.

66. *Arguments Before the Comms. on Pats. of the S. and H.R., Conjointly, on the Bills S. 6330 and H.R. 19853 to Amend and Consolidate the Acts Respecting Copyright*, 59th Cong. 207 (1906) (statement of Albert H. Walker, Counsel, Apollo Company). *See also* ROSEN, *supra* note 44, at 51.

67. ROSEN, *supra* note 44, at 49.

68. *Id.*

the fruits of human creativity, structure and standardize data, or augment human intellectual capacities.

The best-known early example of this kind of system is the Jacquard Loom, which allowed users to encode stitching patterns into punched cards in order to weave intricate patterns in textiles ranging from brocades to rugs.⁶⁹ Invented in France by Joseph Jacquard in 1802, this device relied on interconnected cards that contained information about whether a pair of strands would cross one another on the textile being produced.⁷⁰ As cards moved through the loom, they would pass underneath a cluster of small rods, each corresponding to a strand in the pattern. These rods would fall on the cards at the same time. Rods that fell at the site of perforations would lock their strand in place, while the other ones allowed the strand to shift to the side as the textile exited the loom. The cards were connected to one another, so designs could be as intricate as their designers desired.⁷¹

The Jacquard Loom allowed for the representation of potentially infinite patterns through a system that physically embedded a binary representation (perforation / no perforation) into a highly structured medium (a grid of potential locations on the card where the perforations could be). This technique—to represent and store data on punched surfaces that could control mechanical devices—entered the U.S. music industry in the mid-1800s.⁷² Consider, for example, a patent titled *Mode of Making and Playing Tunes to Produce Music*.⁷³ It was issued to two Ohio inventors, James Bradish and Adoniram Hunt, in 1849. The first claim of this patent covered the “making and application” of perforated sheets to “operate hammers, weights, keys, valves, levers, wires or springs to produce music or musical tunes.”⁷⁴ The second covered the connection between both ends of the paper sheets to create endless loops of the songs and the mechanisms that allowed the sheets to pass through the instrument itself. In this system, the holes in the paper would indicate which notes the instrument would play. A grid of springs with pins attached at their ends pressed against the sliding paper,

69. JAMES ESSINGER, *JACQUARD’S WEB: HOW A HAND-LOOM LED TO THE BIRTH OF THE INFORMATION AGE* 4–5 (2004).

70. *Id.* at 4, 35.

71. *Id.* 35–36.

72. See *Mode of Making and Playing Tunes to Produce Music*, U.S. Patent No. 6,006, at 1–2 (issued Jan. 9, 1849).

73. *Id.*

74. *Id.* at 2.

dropping through the holes, and bouncing back up as the paper rolled past them.⁷⁵

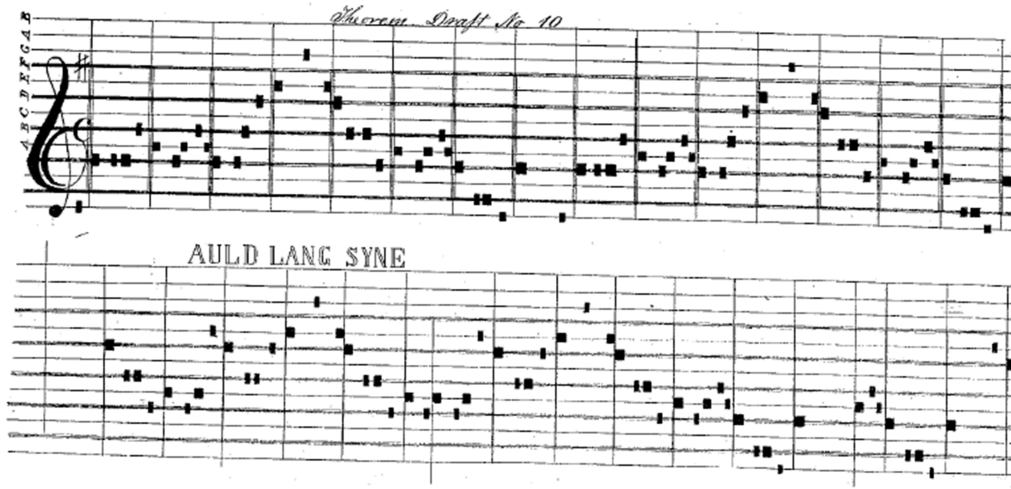


Figure 2. The image on the top shows the location of the perforations on a printout that indicates their correspondence with musical notes in traditional notations. The small letters and symbols at the top left provide enough information to decipher the song. The image on the bottom does not show this additional information, but it can still be deciphered by a reader familiar with the system. Adoniram Hunt and James Bradish, *Mode of Making and Playing Tunes to Produce Music*. US Patent 6,006 (issued January 9, 1849).

Creating punched rolls for Bradish and Adoniram's system was a relatively simple task. As shown in Figure 2, the holes in each sheet were arranged along thirteen rows, each corresponding to a note. To create a roll based on a given song, the manufacturer would simply punch holes into the sheet's rows in the correct order. The spacing between the punches would dictate how much time would pass between two notes, and the width of the hole would dictate how long the instrument would hold the note.⁷⁶ It is worth noting that the system shown in Figure 2 is not the standard sheet music notation: consecutive horizontal lines correspond to consecutive notes in the standard letter notation: C, D, E, F, G, A, B.⁷⁷ There are no notes in between the

75. *Id.* at 1.

76. *Id.* at 1–2.

77. *Id.*

horizontal lines, and the length of each individual note is determined by the width of the perforation instead of a traditional stem and flag.⁷⁸

Bradish and Adoniram's notation system was useful precisely because anyone with basic musical training would be able to read and write melodies in this way. The question that would later permeate discussions over the status of punched rolls under copyright law—whether they could be read by a properly trained human being—was easy to answer if the rolls were presented as in the top of Figure 2. The problem was, however, that Bradish and Adoniram's system did not actually require the finished rolls to be annotated with the lines and symbols shown in that image. Those markings were a form of disposable musical scaffolding that would allow a person with musical training to read and write in this form if needed.⁷⁹ The automatic players only required perforations that, on their own, would not provide enough information for a musician to decipher the melody. Reading one such roll without studying it first would likely require, at least, an indication of whether consecutive holes represent notes that are a full step or half step apart.⁸⁰

Bradish and Adoniram's invention was an early instance of a practice that would continue for more than a century: inventors on both sides of the Atlantic used idiosyncratic musical notations to transform standard sheet music into the rolls required to operate player pianos.⁸¹ Their patents sometimes disclosed the specific graphic layouts that would have allowed a user to translate a roll into traditional staff notation and vice versa. For example, a Viennese inventor named Rudolf Kurka obtained the 1881 patent shown in Figure 3.⁸² His invention was an automatic system wherein the punch of a piano's key would cause an electrical circuit to cut an incision into the key's corresponding place in a paper roll.⁸³ The roll would move continually across the system's blades at the pace determined by the user, so that holding down a key would cause the incision to become longer. The bottom of the image shows the perforations on the paper roll, including a grid that did not necessarily need to be printed on the commercial versions of the roll itself. Note that on the left-hand side of the grid is

78. See *id.* at 2; Deposition of William A. Webber, Transcript of Record at 37a, *Kennedy v. McTammany*, 33 F. 584 (C.C.D. Mass. 1888) (No. 1933).

79. Deposition of William A. Webber, Transcript of Record, *supra* note 78, at 37a.

80. *Id.* at 44–45, 47.

81. See, e.g., *Apparat zur Notirung der auf Tasten-Musikinstrumenten gespielten Töne mit Anwendung des Elektromagnetismus*. Ger. Patent No. 13,928 (issued July 12, 1881).

82. *Id.*

83. *Id.*

a vertical arrangement of a piano's keys that indicates which note is encoded in each row. Similar systems of manufacturing were even employed to create traditional sheet music.⁸⁴ For instance, Figure 4 shows a paper sheet drawn from an automatic printing piano developed by Lillian Rissman, a Chicago inventor.⁸⁵ Just as Kurka's invention created incisions of variable length, this one printed notes of variable length and arranged them on a sheet.

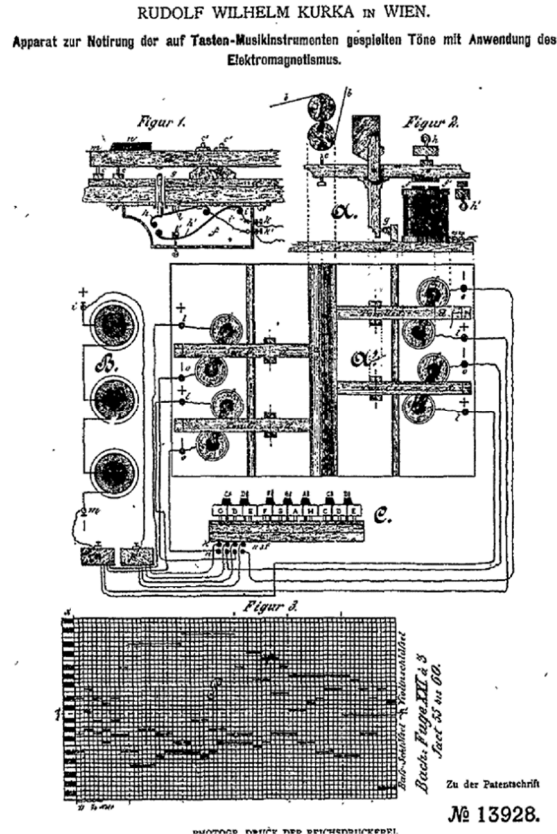


Figure 3. Automatic system that generates punched rolls based on a piano player's performance. A portion of a sample roll, containing printouts for ease of reading, is at the bottom. Note the small vertical keyboard at the left-hand side of this portion. Rudolf Kurka, *Apparat zue Notirung der aud Tasten-*

84. See, e.g., *Apparatus for Recording Music*, U.S. Patent No. 722,904 (issued Mar. 17, 1903).

85. *Id.* at fig. 5.

Musikinstrumenten gespielten Töne mit Anwendung des Elektromagnetismus. German Patent 13,928 (issued July 12, 1881).

No. 722,904.

PATENTED MAR. 17, 1903.

L. O. RISSMAN.
APPARATUS FOR RECORDING MUSIC.
APPLICATION FILED DEC. 2, 1902.

NO MODEL.

2 SHEETS—SHEET 2.

Fig. 5.

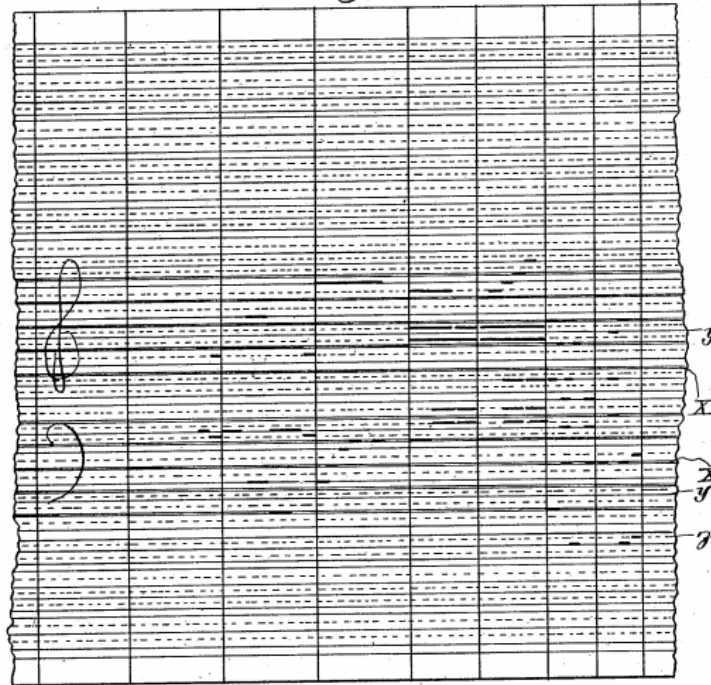


Figure 4. Cross section from a roll created using Lillian Rissman's automatic printing piano. Note the two clefs, which users can add to the roll to indicate the key in which the song is written. Lillian Rissman, Apparatus for Recording Music. US Patent 722,904 filed December 2, 1902 and issued March 17, 1903.

During the second half of the nineteenth century—while punched rolls were becoming a mass-produced good born from an eclectic collection of musical notations—inventors interested in data processing also took note of the infinite potential of perforated surfaces. Historians of computing have documented this process very thoroughly, but a few

words about its origins are in order.⁸⁶ The story normally begins with the work of two British computing pioneers, Charles Babbage and Ada Lovelace, who considered punched surfaces to be the tools necessary to create a device that could string together infinite arrays of mathematical calculations.⁸⁷ In the 1840s, they even envisioned different categories of punched cards—variable cards, combination cards, and index cards—that would allow them to input quantities and instructions into the Analytical Engine.⁸⁸ Babbage and Lovelace never built the Analytical Engine, but their reliance on punched cards was foundational to the history of information technology.

The introduction of punched surfaces into the technological and commercial environments from which modern computing would grow took place in the late 1800s. Tabulating machines of the 1880s allowed users to process thousands, if not millions, of data points automatically.⁸⁹ In the United States, the statistician John S. Billings, who had helped process the 1880 census, conceived of a system that would allow him to represent an individual's census data in a single punched card designed for mechanical data processing (namely, the rapid addition required to compute census totals).⁹⁰ In 1884, one of his colleagues at the Census Office, Herman Hollerith, expanded this device to incorporate electric card reading technology.⁹¹ A grid of metal pins would fall on each card in such a way that those pins that passed through the card's perforations would land on an electrified plate. The electricity would travel through these pins, causing the machine to add one to a counter corresponding to that pin.⁹² This system had such unprecedented speed and computational capacity that it sparked a data

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86. See, e.g., LARS HEIDE, PUNCHED-CARD SYSTEMS AND THE EARLY INFORMATION EXPLOSION, 1880–1945, at 15 (2009); MARTIN CAMPBELL-KELLY, WILLIAM ASPRAY, NATHAN ENSMENGER & JEFFREY YOST, COMPUTER: A HISTORY OF THE INFORMATION MACHINE 14 (2014).
87. SUBRATA DASGUPTA, IT BEGAN WITH BABBAGE: THE GENESIS OF COMPUTER SCIENCE 21 (2014).
88. *Id.* at 21–22.
89. JAMES CORTADA, BEFORE THE COMPUTER: IBM, NCR, BURROUGHS, & REMINGTON RAND AND THE INDUSTRY THEY CREATED 1865–1956, at 46 (2000).
90. John S. Billings, *Mechanical Methods Used in Compiling Data of the 11th U.S. Census*, in 40 *Proceedings of the American Association for the Advancement of Science* 407 (1891). See also HEIDE, *supra* note 86, at 22; CORTADA, *supra* note 89, at 48.
91. CORTADA, *supra* note 89, at 47–48.
92. Art of Compiling Statistics, U.S. Patent No. 395,782, at 2 (issued Jan. 8, 1889).

processing revolution that would make punched cards relevant to electronic computing technology for most of the next century.⁹³

Unlike rolls for player pianos, early punched cards designed for use with computing equipment were not blank surfaces, especially by the century's end. On the contrary, each punched card represented a bundle of data, and a printed image on the card itself would allow a person familiar with the overarching data organization systems to read its contents. For example, Hollerith's cards, shown in Figure 5, displayed a series of tables corresponding to the different categories of information that the census was collecting. The individual punches indicated the corresponding person's categorization within the census, along with the numerical answers to the questions they had answered. In contrast, the surfaces designed for use with automatic instruments did not need to be heavily marked. Pianola rolls could have some printed markings, including basic information about the song and the rolls' position within the machine and, sometimes, printed music symbols that allowed the user to adjust the song's tempo.⁹⁴ However, this was not the norm, as it was for punched cards.

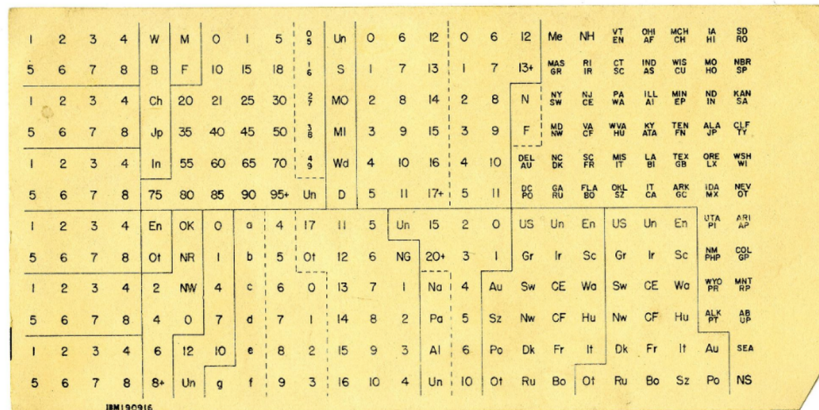


Figure 5. A punched card used in the 1900 census. Note the matrix of letters and numbers, which allowed human users to decipher or produce the card's perforations if they were familiar with the underlying data classifications. Courtesy of the Division

93. CORTADA, *supra* note 89, at 46.

94. See Deposition of William A. Webber, Transcript of Record, *supra* note 78, at 43 (explaining that perforated music rolls have some printed markings when used in larger instruments).

of Medicine and Science, National Museum of American History, Smithsonian Institution.

A key difference between punched cards and piano rolls was each surface's relationship with its makers' creativity. In data processing, punched cards were intended as mechanisms for the accumulation and organization of data. Unlike the surfaces used with instruments and looms, they were not designed to capture the results of a person's creative efforts; their primary purpose was to feed information into a machine that would then generate new statistical insight.⁹⁵ It is therefore unsurprising that it was in the music industry that the problem of assessing their copyright status became most pressing. There, piano rolls were generally created based on a song that already existed. Like the cards of a Jacquard loom, rolls were designed to capture a creative work and make it reproducible through mechanical means.

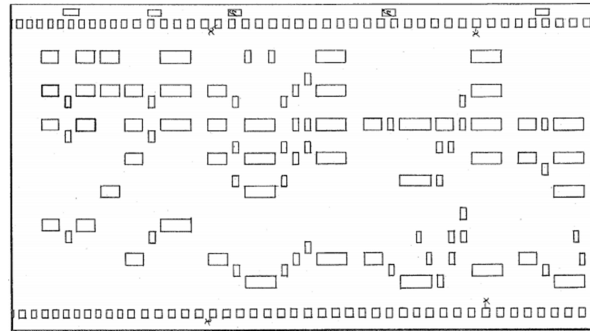
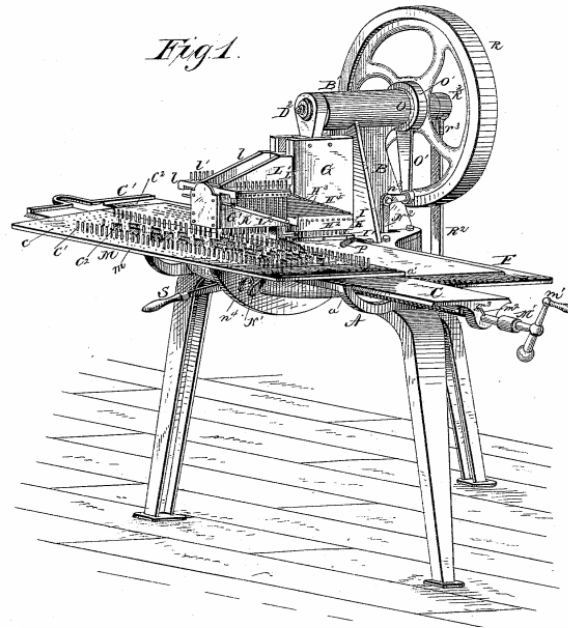
This is not to say that stakeholders in the music industry necessarily tended to think of these rolls as fixations of composers' creativity. On the contrary, a purely mechanical conception of these rolls steadily gained footing in the music industry, sustained in part by the effort to transform them into low-cost manufactured goods.⁹⁶ At times, inventors even secured patents over the rolls themselves—that is, over the paper roll encased in a hard cover that allowed it to be mounted into a player piano.⁹⁷ Devices that automatically reproduced existing rolls did not require users to take any intermediate steps using a printed image to make sense of the musical meaning of the tones; they simply stamped out pieces of paper according to a prearranged pattern. For instance, Figure 6 shows Henry B. Horton's 1884 patent, *Machine for Punching Perforated Sheet-Music*.⁹⁸ The invention consisted of a long board with a grid of perforations on which the user could mount pins in accordance with the melody at hand. The paper could be laid flat over this series of pins, and it would then slide horizontally under a plate that moved up and down, causing the pins to punch holes on the paper. The position of each pin indicated which note would be punched, and the length of the note would be determined by the number of contiguous pins that the user placed on the board. A printed system that allowed humans to read the roll may have been needed for the creation of the original, but that was irrelevant to the automatic duplicator.

95. See CORTADA, *supra* note 89, at 46.

96. See THE PURCHASER'S GUIDE TO THE MUSIC INDUSTRIES 251, (John C. Freund ed., 1922).

97. See, e.g., Music-Roll for Pianolas, U.S. Patent No. 314,748 (issued Aug. 13, 1907).

98. U.S. Patent No. 300,368 (issued June 17, 1884).



No. 300,368.
Patented June 17, 1884.

Figure 6. The device on the top is Henry Horton’s machine to create “perforated sheet-music.” Despite its name, the rolls that this device produced were not standard sheet music, but unmarked rolls that did not contain enough information for users to decipher any melodies with ease. *Machine for Punching Perforated Sheet-Music*, U.S. Patent No. 300,368 (issued June 17, 1884).

III. THE LEGIBILITY OF PUNCHED ROLLS

Punched rolls and music sheets could encode the same songs, but the absence of sufficient visual cues on the former meant that the two were not functionally or commercially equivalent. As a result, the problem of determining the rolls' status under copyright law revolved around that of deciding whether human beings could use the rolls in lieu of standard music sheets. This was a difficult problem that courts were handling while player pianos were spreading around the world. One of the most important legal conflicts in this vein involved a Brooklyn-based composer named William Kennedy, who in 1880 completed what would become one of his most popular songs to date. Best known for his tragic lullabies, Kennedy titled his latest creation "Cradle's Empty, Baby's Gone" and deposited the score and lyrics at the Library of Congress.⁹⁹ He also granted a Boston publisher called Oliver Ditson & Company exclusive rights to the sheet music containing his melody and lyrics.¹⁰⁰ Before the end of the year, Oliver Ditson was distributing "Cradle's Empty, Baby's Gone" through its offices in Boston, Chicago, New York, and Philadelphia.¹⁰¹ At the bottom of the cover page, in small italicized print, was a notice: "Copyright 1880, by Wm. H. Kennedy."¹⁰²

By the time Kennedy completed "Cradle's Empty, Baby's Gone," one of the latest sensations in popular musical technology was the organette (Figure 7). Also known as orguinettes, organinas, or autophones, these instruments were very portable; some of the hand-powered models could even fit in the palm of their user's hand.¹⁰³ An organette's sound-production mechanism comprised a collection of internal reeds that would vibrate in response to wind currents that traveled from an air pump to a row of openings on the top of the instrument, each one containing one of the reeds.¹⁰⁴ Users would feed a roll of punched paper into the top of the device, so the roll would slide over the openings. This paper would manipulate the air currents in accordance with its hole pattern; each hole would allow the air to escape, thus causing the reeds to vibrate. The locations of these perforations would determine which notes the organette would play, and the width of each hole would dictate a note's duration. This system

99. See Bill of Complaint, Transcript of Record, *supra* note 78, at 2.

100. See WILLIAM KENNEDY, *Cradle's Empty Baby's Gone* (Boston, Oliver Ditson & Co. 1880), <https://levysheetmusic.mse.jhu.edu/sites/default/files/collection-pdfs/levy-105-034.pdf> [<https://perma.cc/Q6F3-QV2M>].

101. See *id.*

102. *Id.* at 1.

103. See Bill of Complaint, Transcript of Record, *supra* note 78, at 5.

104. *Id.*

also allowed for easy harmonization, as holes placed on the same column of the paper would cause the corresponding notes to be played simultaneously.¹⁰⁵

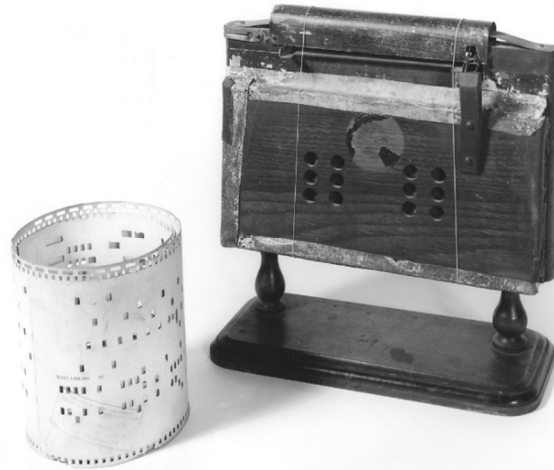


Figure 7. This is an organette. Its manual pump comprises the entire front panel, which has a few holes in the center to allow for air circulation. Courtesy of the Division of Cultural and Community Life, National Museum of American History, Smithsonian Institution.

Without the punched paper, an organette would not be able to play any songs at all. In fact, depending on the organette model, pressing down on the air pump without inserting a piece of paper would just cause a cacophony. The industry for these rolls consisted primarily of young companies, and it had very low barriers to entry: a roll manufacturer would simply need a properly trained person to translate sheet music into the sequence of holes that would cause the organette

105. Portable organettes were smaller, hand-operated predecessors of the more complex device described in Henry Horton's Machine for Punching Perforated Sheet Music patent. *See* U.S. Patent No. 300,368, at 1 (issued June 17, 1884); *see also* Deposition of William A. Webber, Transcript of Record, *supra* note 78, at 45.

to play that song's melody.¹⁰⁶ Once the initial roll had been created, any copies of it could be done either manually or with the aid of an automatic hole punching system. The rising popularity of automatic instruments allowed roll punching firms to reuse mechanical roll translators and automatic duplications across a range of instruments, thus reducing their costs while providing the goods essential for the operation of those instruments.¹⁰⁷

Some organette roll manufacturers purchased licenses from composers and publishers prior to manufacturing rolls based on their work. Among the companies that did so regularly was the Automatic Music Paper Company, the Boston-based firm that would soon merge into the Aeolian Company.¹⁰⁸ By June 1882, Automatic Music Paper had purchased an exclusive license to make, sell, and publish rolls for "Cradle's Empty, Baby's Gone."¹⁰⁹ This song was ideally suited for performance on a portable organette, the small size of which limited the number of notes the instrument would be able to play. It was short and simple, and its last third comprised a four-voice harmonization using a narrow range of notes that even a small instrument would be able to play.¹¹⁰

The ease with which these rolls could be duplicated encouraged a manufacturer named John McTammany to enter the organette roll industry without securing the proper licenses. No records of McTammany's sales are available for research, but in 1883 Kennedy and the Automatic Music Paper Company sued McTammany for copyright infringement at the U.S. Circuit Court for the District of Massachusetts.¹¹¹ Kennedy's lawyer, August Russ, advanced the notion that the rolls themselves constituted a new form of musical notation.¹¹² In response, McTammany's lawyer, Chas. Theo. Russell, argued that the rolls are a "purely mechanical manufacture and an appliance for

106. See Deposition of William A. Webber, Transcript of Record, *supra* note 78, at 37b (explaining that to be an arranger of music for organettes simply requires familiarity with reading sheet music).

107. See THE PURCHASER'S GUIDE TO THE MUSIC INDUSTRIES, *supra* note 96, at 251, 253.

108. See Amended Bill of Complaint, Transcript of Record, *supra* note 78, at 14, 17; *History of the Manufacturer: The Aeolian Company*, RADIOMUSEUM.ORG (Nov. 19, 2020), https://www.radiomuseum.org/dsp_hersteller_detail.cfm?company_id=16474 [<https://perma.cc/3GQT-QWQ7>].

109. Amended Bill of Complaint, Transcript of Record, *supra* note 78, at 17.

110. See KENNEDY, *supra* note 100, at 5.

111. See Transcript of Record, *supra* note 78, at 2.

112. Answer, Transcript of Record, *supra* note 78, at 24.

and a separate and distinct part and portion of a musical instrument.”¹¹³ Russell saw Hunt and Bradish’s 1849 patent as further evidence to justify this mechanical conception of the rolls.¹¹⁴ This would suggest that the rolls themselves belonged to the useful arts—a category of creations that, according to the Supreme Court’s opinion in *Baker v. Selden*, belonged to the realm of patents, not copyrights.¹¹⁵ For this reason, Russell insisted, there was no evidence of “any infringement or piracy whatever of the words, or music, or song, musical composition, score or book.”¹¹⁶

Russell aimed to establish that perforated paper could not possibly be construed as a form of musical notation. He explained that the differences between the printed score for “Cradle’s Empty, Baby’s Gone” and the punched paper were “so great there is no comparison between them.”¹¹⁷ The cornerstone of his argument was the fact that the paper rolls did not have any printed signage that suggested the presence of a traditional staff notation. After outlining the basic features of such a notation, his brief explained that printed characters such as sharps, flats, and rests are nowhere to be found even though they are “essential to a proper interpretation of [a] piece and the absence of any one of them would make the piece unintelligible.”¹¹⁸ To this end, he explained that in a punched paper:

There is no clef to locate the pitch, no sharps or flats to indicate the key, no bars or measures to show its rythmical [sic] structure, no figures or letters to designate the kind of measure, or the accent, nothing to show expression, nor in fact any of the many signs or characters that become absolutely necessary to even convey an impression or conception of the author of the musical composition.¹¹⁹

This revealed that Russell was relying on a strikingly narrow conception of what constitutes a notation. Nineteenth century music historians and scholars, addressed in this article’s final section, tended to embrace much broader conceptions of what a notation is. They were aware of historical examples that did not resemble traditional staff notation and would not have necessarily endorsed this reasoning. However, at the court, Russell’s argument underscored the fact that

113. *Id.*

114. Amended Bill of Complaint, Transcript of Record, *supra* note 78, at 16.

115. 101 U.S. 99, 105 (1879).

116. Demurrer, Transcript of Record, *supra* note 78, at 12.

117. Answer, Transcript of Record, *supra* note 78, at 25.

118. *Id.* at 29.

119. *Id.*

organette rolls, unlike other systems with which humans have conveyed musical meaning to others, lacked the visual cues necessary for a human being to identify the specific melody that corresponds to a sequence of perforations. This lack of signage was enough, in his view, to categorize rolls as mechanical inventions intended to be used by a machine.

The court ultimately endorsed this mechanical conception of the rolls and sided with McTammany, though it did not fully embrace Russell's unusually restrictive definition of what constitutes a musical notation. In 1888, Judge J. Colt explained that he was unconvinced that the paper strips are "copies of sheet music, within the meaning of the copyright law."¹²⁰ These strips were "not made to be addressed to the eye as sheet music."¹²¹ The key difference between the strips of paper and traditional sheet music was, in Colt's view, their respective uses. Each roll was, instead, "part of a machine"—a "mechanical invention made for the sole purpose of performing tunes mechanically upon a musical instrument."¹²² In this sense, the use of a roll "resembles more nearly the barrel of a hand organ or music box."¹²³ Colt was also unconvinced by the argument that the paper strips constituted a new form of musical notation meant for human use. He did not deny that a musically inclined person could conceivably spend enough time studying the structure of the strips and learn how to read unmarked strips, but musicians were simply not using the rolls for this purpose. In short, the fact that rolls could be read was more of the result of "an experiment" with a mechanical component than a trait central to their design.¹²⁴

Within a few years, courts in England arrived at a similar conclusion—that even if the rolls could *become* legible to human beings, their design and structure suggested that they were not, in fact, intended to constitute a musical notation for human use. One case, *Boosey v. Whight*, concerned the punched rolls used with the Aeolian.¹²⁵ The plaintiff, a publisher, was suing a distributor of those rolls for copyright infringement of three of its songs. Unlike the sheets in the *Kennedy* case, however, these rolls had a few printed markings throughout. Their beginning had a brief indication of which key the song was on, presumably so that the rolls' user could purchase the corresponding vocal sheets. Some of the rolls also had printed material alongside the perforations—words such as *piano*, *andante*, *moderato*, or *crescendo*. These words indicated the volume changes intended for their

120. *Kennedy v. McTammany*, 33 F. 584, 584 (C.C.D. Mass. 1888).

121. *Id.*

122. *Id.*

123. *Id.*

124. *Id.* at 584–85.

125. *Boosey v. Whight* [1899] 1 Ch 896.

corresponding passages, and they alerted the human user to push the instrument's pedals at a different speed to adjust the playback speed as needed. As in the *Kennedy* case, the English court did not doubt that a musically inclined person could potentially learn how to read the melodies corresponding to the perforations, but none of the witnesses on either side testified that they had been able to do so.¹²⁶ Furthermore, the court found that “the rolls constitute an extremely cumbersome system of writing music, hardly available without the use of some mechanism which at present does not exist.”¹²⁷ This made it “improbable that any one would ever go to the trouble of acquiring the art of reading these rolls.”¹²⁸

By placing rolls outside of the realm of objects intended to be read, the court was effectively excluding them from the “books” category of English patent law, which included sheet music.¹²⁹ The court conceded that there was “a somewhat unusual and difficult form of notation” at play, but the objects that hold this notation are intended to be used as mechanical parts.¹³⁰ As a result, the creation of the rolls themselves did not constitute infringements of the exclusive rights of “printing or otherwise multiplying copies.”¹³¹ This was not to say, however, that the distributor had not committed any form of copyright infringement. The court found that the reproduction of text taken from the music to convey changes in the song's pace and expression constituted infringement and ordered an injunction to stop the rolls' distribution.¹³²

Both parties in the *Boosey* case appealed this opinion, and a few months later a higher court reinforced and expanded the idea that ease of human legibility was a precondition for the assessment of copyright infringement in punched rolls.¹³³ In agreement with the lower court, it wrote:

Conceding for the sake of argument that a person might be trained to play or even to sing from the perforated sheets, it is clear that they are not made to be so used, nor are they ever so used in fact; and we ought, in my opinion, to deal with the case

126. *Id.*

127. *Id.*

128. *Id.*

129. *Id.*

130. *Id.*

131. *Id.*

132. *Id.*

133. *Boosey v. Whight* (1900), 81 LT 571 (AC) at 572–73.

on broad business lines and not on unpractical, though theoretically possible, assumptions.¹³⁴

The appeals court further grounded its reasoning on an even more basic reason why the rolls themselves were not protected by copyright: composers had no universal rights over the songs they created, as their copyrights were restricted solely to the sheets of music that they wrote. “[T]he plaintiffs have no exclusive right to the production of the sounds indicated by or on those sheets of music,” the court wrote, “nor to the performance in private of the music indicated by such sheets; nor to any mechanism for the production of such sounds or music.”¹³⁵ The court also found that perforated sheets could not be said to be a copy of sheet music “unless the word ‘copy’ is used in a very loose and inaccurate sense.”¹³⁶



Figure 8. A wax phonograph cylinder. The music is engraved onto the layer of beeswax that coats it. Courtesy of the Division of Work and Industry, National Museum of American History, Smithsonian Institution.

134. *Id.* at 574.

135. *Id.*

136. *Id.*

Back in the United States, emerging legal battles surrounding developments in phonograph technology further reinforced the notion that manufacturers were not committing copyright infringement when they created these kinds of devices.¹³⁷ Unlike automatic pianos and organettes, which played songs in real time, phonographs were intended to play back a recording.¹³⁸ Thomas Alva Edison's first experiments in this field during the 1870s had relied on wax paper to store sound recordings. Since then, metal cylinders covered in beeswax had become the standard storage medium for songs and voice recordings.¹³⁹ Unlike punched rolls, these cylinders (shown in Figure 8) could not at all be read by human beings, regardless of how much time they took to familiarize themselves with how they worked. The recordings were etched into the beeswax itself and could only be read by a small needle that fit exactly into the width of the engraved grooves.

In 1901, the Appeals Court of the District of Columbia ruled that the unauthorized manufacture and use of these cylinders did not constitute copyright infringement.¹⁴⁰ Its summary judgment, *Stern v. Rosey*, stated that the meanings of the words “copying” and “publishing” in the Copyright Act did not apply to “the reproduction, through the agency of the phonograph, of the sounds of musical instruments” playing a composer's music.¹⁴¹ The marks on the cylinders conveyed “no meaning” to the eye and were “wholly incapable of use save in and as part of a machine specially adapted” for that purpose.¹⁴² Certainly, recordings of ambient sounds were different from the mechanical use of perforations, but *Stern v. Rosey* provided a legal language with which to articulate the increasingly mechanical conception of punched rolls that was spreading across the player piano industry. It reinforced the notion that copyright was intended to protect the physical creation of a composer (the music sheets) and not the intangible creation that this physical object was meant to store, reproduce, or encode. This was exactly the line of thought that Aeolian would try to end through *White-Smith v. Apollo*.

IV. THE AEOLIAN STRATEGY

Aeolian covered the costs of hiring prominent lawyers—Edwin Brown, Louis Raegner, and Alexander Browne—to represent White-

137. See ROLAND GELATT, *THE FABULOUS PHONOGRAPH, 1877–1977*, at 131–32 (1977).

138. See *id.* at 134.

139. *Id.* at 71.

140. *Stern v. Rosey*, 17 App. D.C. 562, 565 (D.C. Cir. 1901).

141. *Id.* at 564–65.

142. *Id.* at 565.

Smith.¹⁴³ These lawyers went to great lengths in their efforts to distinguish their case from the precedent set by *Kennedy v. McTammany*, *Boosey v. Whight*, and *Stern v. Rosey*. In fact, their complaint to the Circuit Court of the Southern District of New York does not even mention the fact that the case involves perforated rolls.¹⁴⁴ It presented a simple story about a composer named Adam Geibel, who had written two popular songs in the blackface minstrelsy genre, “Little Cotton Dolly” and “Kentucky Babe Schottische.”¹⁴⁵ Geibel had copyrighted his “musical composition[s]” and granted White-Smith the right to publish them with the notice required by law: “Copyright 1897 by White-Smith Music Pub. Co.”¹⁴⁶ Sometime in 1902, the Apollo Company, a distributor of Melville Clark players, started to “publish and sell great numbers of copies of said musical composition[s]” and continued to threatened to do so.¹⁴⁷

The Aeolian strategy consisted of demonstrating that the perforated rolls themselves were a musical notation, and that there was nothing unusual about using notations other than the one for standard sheet music.¹⁴⁸ The promise of this strategy lay in the fact that the opinions examined above had clearly established that copyrights extended to the printed sheets that they produced, and not to the music itself. If courts found that the rolls themselves constituted a notation, then it would be easier to argue that manufacturing an unauthorized roll was akin to creating an unauthorized copy of a music sheet. In other words, establishing rolls as objects that qualified as “copies” under copyright law would enable Aeolian to bypass the argument that the rolls themselves were purely mechanical components. To this end, White-Smith’s lawyers spent more than a year gathering testimony to justify this argument.¹⁴⁹ They likely reasoned that their predecessors at the Automatic Music Paper Company had lost *Kennedy v. McTammany* in large part because the lawyers before them had failed to gather testimony along those lines.

The lawyers reached deep into Aeolian’s extensive network of scholars, composers, entrepreneurs, and manufacturers. The testimony of George C. Gow, a professor of music at Vassar College best known

143. See *White-Smith Music Publ’g Co. v. Apollo Co.*, 139 F. 427, 428 (C.C.S.D.N.Y. 1905).

144. See generally Bill of Complaint, Transcript of Record at 1, *White-Smith Music Publ’g Co. v. Apollo Co.*, 209 U.S. 1 (1908) (Nos. 110, 111).

145. *Id.*

146. *Id.* at 2.

147. *Id.*

148. For an overview of this strategy, see ROSEN, *supra* note 44, at 51–52.

149. *Id.*

for a textbook titled *The Structure of Music*, is representative of most of the testimony they received.¹⁵⁰ A composer and theorist, Gow regularly used an automatic organ called the Orchestral in his lectures.¹⁵¹ He told Raegner that a musical composition is “an orderly combination of musical tones renderable by musical instruments or the voice” and that a notation is what makes an author’s composition reproducible by others.¹⁵² A notation—which he defined as a “presentation to the eye of that which if presented to the ear would make music”¹⁵³—need not be textual in nature, because its role is to record the author’s “musical conception” and render it reproducible by others.¹⁵⁴ In this sense, punched piano rolls are “another form of notation,” and the automatic piano becomes an instrument in the sense that it “translates a notation into terms of action.”¹⁵⁵

The fact that a mechanism would play the rolls automatically was irrelevant to Gow. After all, musicians would regularly need pedals, mechanical levers, and other mechanical aids in order to play a song.¹⁵⁶ A musician pushing a piano’s pedal, for example, would not need to worry about controlling the motion of the internal mechanisms that modified the piano’s resonance. Instead, upon the musician’s push, a series of levers would automatically lift the piano’s dampening devices, causing the strings to vibrate for a longer period.¹⁵⁷ In other words, Gow construed playing the piano as an activity that necessarily required mechanical aids. This made an automatic piano just another kind of musical instrument in his view, albeit one in which the mechanical systems are more complex and in which human intervention is only required to place the musical notation in the proper place. The same was true of organs, which even allowed musicians to control a note’s loudness and color by interacting with levers and pedals that triggered more complex mechanical functions.¹⁵⁸

Still, Gow’s understanding of notations as visual media hinged on the assumption that a musician would be able to read them. For piano rolls to be considered notations in this sense, it was therefore necessary

150. Testimony of George C. Gow, Transcript of Record *supra* note 144, at 38.

151. *Id.* at 38–39.

152. *Id.*

153. *Id.* at 41.

154. *Id.* at 39.

155. *Id.*

156. *Id.* at 41.

157. Michael Lane, *Chapter 9-Piano Pedals*, FLOWKEY, <https://www.flowkey.com/en/piano-guide/piano-pedals> [https://perma.cc/E7H9-N9JE] (last visited Jan. 1, 2021).

158. Testimony of George C. Gow, Transcript of Record, *supra* note 144, at 41.

to determine whether they could, in fact, be read by human beings. Gow himself was convinced that this posed no problem.¹⁵⁹ To test this, the lawyers used a Pianola to play a roll containing an original composition by Alexander Guilmant, a French organist and composer.¹⁶⁰ Guilmant was globally prominent, but this song was not. It was an improvisation that he had recorded only once, likely at the lawyers' request, by attaching an automatic punching device to his own piano.¹⁶¹ After the song's end, one of the lawyers gave the roll to Gow and asked him if he would be able to read the notes on the roll, sing them, and write the song using traditional staff notation.¹⁶² Gow explained that he could do so "without difficulty" and that a cursory glance at the roll was enough for him to "recognize what music would be played," but he didn't actually offer to do it.¹⁶³

Testimony like Gow's was not enough for White-Smith's lawyers, as assurances that the rolls were legible were not nearly as convincing as a demonstration. Leonard B. McWhood, one of Gow's colleagues at Vassar, tried to perform the translation from roll to staff notation that Gow had described.¹⁶⁴ McWhood stated that he had first noticed his ability to do this when he picked up a piano roll at a friend's house and was able to decipher the song by looking at the perforations.¹⁶⁵ Reminiscing on this experience, he told the lawyers:

I read over the opening measures of the perforated roll record, and from this record alone played the beginning of the piece note for note in all parts of the piano. After this, I played the composition for the first time on the Pianola, and it was precisely as I had already played it with my hands on the piano.¹⁶⁶

To test this, one of the lawyers asked McWhood to translate a portion from a roll into staff notation. McWhood agreed to do so with sudden but great reluctance, emphasizing that he thought of his ability to do this was "exceedingly limited," that he would need several minutes to complete the task, and that his acquaintance with perforated

159. *Id.* at 42.

160. *Id.* at 41; *Biography*, FELIX ALEXANDER GUILMANT, <http://www.guilmant.nl/gm/pages/biography.php> [<https://perma.cc/7JV5-GGRW>] (last visited Jan. 1, 2021).

161. Testimony of George C. Gow, Transcript of Record, *supra* note 144, at 41.

162. *Id.* at 41–42.

163. *Id.* at 42.

164. Testimony of Leonard B. McWhood, Transcript of Record, *supra* note 144, at 55.

165. *Id.* at 50–51.

166. *Id.*

rolls is “recent and comparatively small.”¹⁶⁷ He took the roll from the lawyer, who agreed to give him the following information not found on the roll itself: this system could record a total of fifty eight different notes, and that the spacing between the notes was identical to the spacing found in Pianola and Aeolian rolls.¹⁶⁸ This was all the information that the lawyer offered; McWhood was not to know the highest and lowest notes represented in the roll, nor was he to know any additional rules that governed the punching patterns.

This exercise revealed that McWhood was not nearly as fluent in roll interpretation as his personal story implied, nor did he have the high level of comfort reading the roll notation that Gow ascribed to professional musicians. McWhood was unable to determine the time that each of the notes should last, and he could not account for a few variations in the perforation patterns.¹⁶⁹ He had spent nearly twenty minutes simply deciphering the opening chords of the song, through a long and laborious process.¹⁷⁰ Describing his work, he told the lawyers,

I have approached the task in a mathematical way, measuring off more or less accurately the spacings. That has been done in the effort to be exact; therefore, I have consumed a great deal of time on what I consider more or less of a thankless task. . . . Facility in this matter is entirely a question of practice, and I could easily train myself to efficiency if I gave the requisite attention to the matter.¹⁷¹

Backtracking a bit from his initial assessment of how easy it would be to read the rolls, he told the lawyers that “with sufficient training” a person might be able to read the rolls as easily as traditional staff notation.¹⁷² McWhood was confident that reading these rolls would not pose much of a problem, but his own work with the rolls suggested that the process was not as easy as he and Gow thought. This became even clearer after he realized, and told the lawyers, that he had been holding the roll upside down while he performed his calculations, so the melody he had written in staff notation did not at all match what the Pianola would play.¹⁷³ McWhood, like several other people who attempted this translation, had failed.

167. *Id.* at 54.

168. *Id.*

169. *Id.* at 55.

170. *Id.*

171. *Id.*

172. *Id.* at 56.

173. *Id.*

White-Smith's repeated failure to demonstrate that the rolls could be read easily and effectively destroyed any chance of arguing that they constituted a musical notation akin to music sheets. In 1905, after three years, the District Court finally ruled in Apollo's favor. Following the precedent set by *Kennedy v. McTammany* and *Stern v. Rosey*, Judge John Hazel explained that there was no doubt about "the impracticability of reading a perforated sheet of music for the purpose of singing or playing the composition."¹⁷⁴ He further explained that the evidence pointed at the conclusion that "the single purpose of the perforated sheets is to mechanically reproduce musical sounds, and that they are not, like the sheet music, addressed to the vision, or intended to be read."¹⁷⁵ This threw into question whether the rolls' perforations could, indeed, be considered to fall within the purview of copyright law.

The court found no conflict between the opinions on automatic players discussed in the previous section and the broader landscape of copyright law.¹⁷⁶ In 1879, the Supreme Court had established that copyrights give an author or publisher the exclusive right of "multiplying copies of what he has written or printed" and that infringing this right involved producing "a substantial copy of the whole or of a material part."¹⁷⁷ Five years later, the Court had explained that the word "writings" as employed in the constitution referred to "all forms of writing, printing, engraving, etching, &c., by which the ideas in the mind of the author are given visible expression."¹⁷⁸ As a result, Judge Hazel concluded (in alignment with *Kennedy v. McTammany*, *Stern v. Rosey*, and even *Boosey v. Whight*) that the rolls fell outside of the scope of copyright law, and that creating or duplicating them could therefore not constitute copyright infringement.¹⁷⁹ Aeolian appealed this decision all the way to the Supreme Court, but this line of thought remained unchanged: until Congress passed a new copyright act explicitly including mechanical devices such as perforated rolls into the purview of copyright law, roll manufacturers were under no obligation to pay royalties to composers and their publishers.¹⁸⁰

174. *White-Smith Publ'g Co. v. Apollo Co.*, 139 F. 427, 428 (C.C.S.D.N.Y. 1905).

175. *Id.*

176. *Id.* at 431–32.

177. *Perris v. Hexamer*, 99 US 673, 675–76 (1879).

178. *Burrow-Giles Lithographic Co. v. Sarony*, 111 US 53, 58 (1884).

179. *White-Smith*, 139 F. at 431–32.

180. *White-Smith Publ'g Co. v. Apollo Co.*, 209 U.S. 1, 18 (1908).

CONCLUSION

The story of *White-Smith v. Apollo* invites us to ask not just *who* counts as an author, but also *what* counts as a work of authorship. A vast interdisciplinary literature has shown how systematic attention to authorship allows numerous ways of inquiring into the social, cultural, political, and commercial assemblages that frame human creative and technoscientific endeavors.¹⁸¹ Scholars have refined the broad historical frameworks necessary to understand how conceptions of authorship can perpetuate, or transform, the cultures of inquiry and knowledge dissemination from which they emerged. For instance, Peter Jaszi and Martha Woodmansee have noted that “the modern regime of authorship, far from being timeless and universal, is a relatively recent formation,” as it emerged in the late eighteenth century through the self-representation efforts of Romantic poets as creative geniuses.¹⁸² At the same time, historians of science, technology, and literature have uncovered examples of what Mario Biagioli and Peter Galison have called the “co-emergence of scientific and literary authorship” since the early modern period.¹⁸³ Efforts like these have generated the broad historical frameworks necessary to understand how conceptions of authorship can perpetuate, or transform, the cultures of inquiry and knowledge dissemination from which they emerged. Authorship—far from a universal and conceptually stable trait that becomes automatically assigned upon completion of the work—is historically contingent and continually renegotiated in a variety of contexts: as a tool for the attribution of credit, a form of recognizing or denying authority, a way of displaying belonging to (or exclusion from) specific communities, a means of disciplining bodies of work, and a legal and commercial mechanism for the allocation of industrial and cultural resources.

In contrast, focusing on *works* of authorship draws attention to the historical emergence, commercial value, and legal impact of assumptions about the nature of the works that human beings can create. Aeolian’s arguments were much more than just early provocations in the long history of copyright-eligibility discourse. They were also a strategic attempt to give legal credence to an industrially useful conception of a “writing” that would allow the firm to secure exclusive licensing contracts among roll manufacturers. Aeolian’s main obstacle was that it was difficult to argue for the rolls’ status as

181. See *supra* note 12.

182. WOODMANSEE & JASZI, *Introduction*, in THE CONSTRUCTION OF AUTHORSHIP: TEXTUAL APPROPRIATION IN LAW AND LITERATURE 2–3 (Martha Woodmansee & Peter Jaszi eds., 1994).

183. BIAGOLI & GALISON, *Introduction*, in SCIENTIFIC AUTHORSHIP: CREDIT AND INTELLECTUAL PROPERTY IN SCIENCE 4 (Mario Biagioli & Peter Galison eds., 2003).

writings, in part because the myriad uses of perforated surfaces and the broader media landscapes to which they belonged made it easier to argue that they are mechanical components that fall outside of the reach of copyright law. After the long-term battles that Aeolian orchestrated and funded failed, the firm turned its financial and legal resources to lobby for the incorporation of mechanical reproductions in the 1909 Copyright Act.

Nothing inherent to works of authorship in binary coded form makes them necessarily legible or illegible. These works can *become* legible when people gain familiarity with the underlying code's internal logic and symbolic structure. This may require the presence of interpretive scaffolding specific to the code itself—printed symbols for music rolls, grid markings for punched cards, or industry standards like ASCII for today's computers—especially when the code is designed to cause a machine to operate. This scaffolding can be both a communication structure that enables people to write using code and the cryptographic key that allows its deciphering. In the case of music rolls, efforts to reverse engineer a scaffolding (that is, to figure out the rules that govern how the binary code's physical layout determines musical notes) failed because compositions can be represented as binary states in an infinite number of ways. Even some mechanical players, such as early Aeolians, could not convert a coded composition into its intended musical performance unless the person powering the device followed the printed scaffolding's instructions about the melody's tempo.

The question of what constitutes a work naturally leads to what it means to copy it. Oren Bracha has shown how narrow print-based conceptions of *the* copy were not broad or flexible enough to respond to new industrial pressures tied to changes in that what it meant to copy.¹⁸⁴ In this context, *White-Smith* was a staged battle between the earlier print-based frameworks and broader ones designed to disassociate a musician's works from the standard musical notations with which they would normally record and distribute them—a disassociation of creation and ownership that Catherine Fisk has documented in other 19th century industrial settings.¹⁸⁵ In Aeolian's philosophy of copyright, a writing was a fixation of a song that could be read by a pianola and *some* human beings.¹⁸⁶ This meant that piano rolls—which they construed as writings essential to the pianos'

184. See BRACHA, *supra* note 14.

185. See FISK, *supra* note 23.

186. This introduced a training requirement for the interpretation of the creative work, thereby creating a counterpart in copyright law to the POSITA in patent law. See William J. Rankin, *The "Person Skilled in the Art" is Really Quite Conventional: U.S. Patent Drawings and the Persona of the Inventor*, in MAKING AND UNMAKING INTELLECTUAL PROPERTY 55 (Mario Biagioli, Peter Jaszi & Martha Woodmansee eds., 2011).

mechanical operation, their social and cultural impact, and their long-term commercial success—were eligible for copyright regardless of their legibility. To copy a roll was to copy a writing, even if the roll had nothing on it other than a grid of perforations. Variations of this conception of writing lived on for many decades, the history of computer programming. For instance, some computer hobbyists in the 1970s bought their programs in rolls of perforated paper that publishers sold by weight. Sellers computed prices after perforating the rolls to ensure that customers were not paying for the paper disks left behind by the hole punchers. In this system, the monetary value of a string of binary code was determined by the proportion of zeroes to ones that it contained.¹⁸⁷

Codes allowed works of authorship to become mechanical components. Musical compositions emerged from the Aeolian saga as ethereal creations that could be written and owned outside of the histories of printing, publication, regulation, and circulation from which copyright law had emerged.¹⁸⁸ Far from a scholarly or artistic statement about the nature of music, this way of conceptualizing compositions was a strategic weapon in a very intense legal–commercial battle for market dominance in the player piano industry. The legibility of perforated rolls, which Aeolian unsuccessfully tried to establish through music scholars’ translational efforts, was therefore both an exercise in the legal construction of binary coded texts as writings and a precondition for the success of Aeolian’s ambitious business strategies.

187. See CON DÍAZ, *supra* note 1, at 139–160.

188. Like Gitelman, I prefer this phrasing over the popular term “print culture,” which can sometimes be far too vague for historical analysis. See GITEMAN, PAPER KNOWLEDGE, *supra* note 17, at 7–9.