Zeitschrift: gta papers
Herausgeber: gta Verlag
Band: 1 (2017)

Artikel: Tapping machines : listening to the difference, 1928-1956
Autor: Fischer, Sabine von
DOI: https://doi.org/10.5169/seals-791264

Tapping Machines: Listening to Difference, 1928–1956

Sabine von Fischer

Sabine von Fischer is Research Associate at the Zurich University of Applied Science, School of Architecture, Design and Civil Engineering.

Privacy and concerns about noise partake in the history of architecture, science, technology, society, industry, and modernity. Testing architecture's capacity to grant privacy is a task at the nexus of objective measurement, environment, perception, construction, and comfort. Since the 1920s, the coincidence of new construction methods in housing production and distress over privacy challenged the modern architect's belief that lighter buildings with thinner walls would pave the way to the future. This essay examines testing methods devised for measuring sound transmission through the ceilings and floors of neighboring apartments. It discusses sound insulation in architecture as a technological momentum for fulfilling architecture's function of securing acoustic privacy, and addresses difference in multiple ways. It refers to the spatial situations where sound measurements were taken, namely above and below a floor. Then it addresses conflicts between automated measurements and techniques of listening. In short, it aims to deliver another and possibly different history of objectivity in the modern period in architecture.

One of the instruments created in the late 1920s, in an endeavor to resolve the problem of inherent subjectivity in sound assessment, was the "machine for producing impact sounds." Later it became known as the "tapping machine," or "Hammerwerk" in German, or "machine à chocs" in French: a stunningly simple mechanism that hammered on floors to test their acoustic qualities as well as the level of sound insulation provided by various construction types. This hammering apparatus appears at first glance to bring architecture and machine into a straightforward sonic relationship. However, the human hearing threshold, until around 1930 was part of the test too, and this entangled architecture and machine in a more complicated relationship, one of mediatized sensation. Automation of the tests relieved the acoustic sciences of this tension. Yet still, the differences between measuring sound with an apparatus and assessing sound by hearing left ample room for debate.

Designed to test construction methods in the laboratory as well as on-site, the tapping machine also tested the test setting itself. Tackling this problem of the complicated relationship between hammering, acoustic measurement, sonic perception, and privacy as a function of architecture calls for a "*stubbornly realist attitude*." [1] Such a realist attitude is an aid to overcoming the self-confinement of architectural criticism in formal or aesthetic loops. In the history of twentieth-century architecture,

1 Bruno Latour, "Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern," *Critical Inquiry*, 30, no. 2 (2004), pp. 225–48; here p. 231. Emphasis in original.

one of the few to address comparable links between technology and comfort was Reyner Banham, who also warned that, "like domestic heating systems, social control systems are disappearing into the floor slab." [2] The pipes of such systems transmitted heat as well as unwelcome sounds into neighboring spaces, and remained invisible but not unheard. Technical apparatuses, laboratory practices, questions of physical comfort, and complaints about noise are a complex that architectural historiography has yet to deal with in full. The history of the tapping machine offers an opportunity to begin such an investigation.

The first part of this paper presents a brief history of the tapping machine. I explain the mechanics and the uses of the apparatus, the design of which was published for the first time by the U.S. National Bureau of Standards in 1928, and subsequently in modified form by other institutes on both sides of the Atlantic. The second part tells of a 1956 episode of reintroducing human hearing into the testing of architectural soundproofing. It questions the master narrative of modern standardization. Long after automation had become the norm for acoustic measurements, Germany's leading expert in architectural acoustics devised a combination of the standardized method for assessing impact sound and listening as a psychophysiological process, when he designed a simple method which included the human ear. Based on the difference between the perceived loudness of two standardized impulses inside and outside of a room, his method provided a practical tool for measurements on-site, beyond the laboratory walls.

2 Reyner Banham, "Softer Hardware," *Ark*, 44 (1969), pp. 2–11.

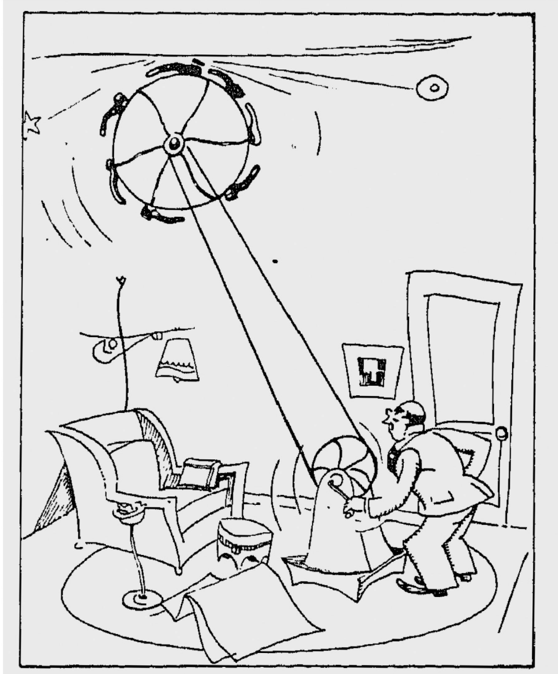
Sleepless in the metropolis, c. 1930

"Wie kann er schlafen durch die dünne Wand?" [3] This refrain—"How can he sleep behind a wall so thin?"—was quoted from an earworm hit in a bestselling novel by the former journalist Gabriele Tergit. The novel tells of life in Berlin around 1930, of mass housing, speculation and corruption in the building industry, and of the rise to fame of a songwriter who gains citywide acclaim with this one song in which noise anxiety plays a key role. Changes in lifestyle clashed with changes in architecture, when a growing variety of noise sources sounded inside of modern, less noise-absorbent, and more densely populated building types. Steel framing, prefabrication, mass production, plumbing and wiring for every unit and every room, and the proliferation of domestic appliances had acoustic consequences, particularly in combination with the increasing density of cities with multi-unit and multistory dwellings. The walls and floors of such dwellings

3 Gabriele Tergit [= Elise Reifenberg], *Käsebier erobert den Kurfürstendamm* (Berlin: Das Neue Berlin, 2004 [1931]), p. 149. For a cultural history of the architectural implications of the novel, see Ines Lauffer, *Poetik des Privatraums: Der architektonische Wohndiskurs in den Romanen der Neuen Sachlichkeit* (Bielefeld: transcript, 2011), pp. 83–117.

transmitted a multitude of bothersome noises to neighboring apartments. f.1

Practices as well as debates concerning sound in the built environment indicate that acoustics were increasingly perceived as integral to the program and function of architecture from the 1920s onwards: while modernist architectural discourses in *L'Esprit Nouveau* and other publications discussed musical techniques and acoustic ambience, the acoustic performance of buildings came to be included in a new scientific apparatus by which architecture was to be planned, built, and evaluated. Architects, scientists, the building industry, and society at large were no longer able to rely solely on empirical knowledge handed down over generations but instead had to tackle questions of architectural performance by examining a multitude of functions, for each of which a set of tools was designed that could assess their feasibility, as part of modernity's endeavor to quantify architectural parameters.



f.1 One man's music is another man's noise (1934).

Acoustics, alongside other new considerations rooted in building physics and climate control (such as lighting, temperature, humidity, and hygiene in general) changed the ways in which structures were described in the early twentieth century. Architecture was seen not only to require a three-dimensional design, but also to involve temporal and programmatic scenarios. John Summerson defended this notion in 1957 by rejecting the "axiom that architecture is an affair of simple geometric forms," and including "the spatial dimensions, spatial relationships and other physical conditions required for the convenient performance of specific functions" in the problems of architectural theory. [4] Summerson's term "performance," with its emphasis on dynamic processes, has proven a useful means to circumvent naïve, static, and deterministic notions of function.

For historiography, function provides a crucial hinge between technological, economic, and social histories. It has been discussed in many different contexts, often in reference to Louis Sullivan's influential plea of 1924, for a utility wherein "forms ... would grow naturally out of ... needs." [5] Notwithstanding the vehement rejection of functional determinism by the cybernetic

4 Summerson, in his original contribution to the quest to find unity in modernity's diverging concepts, notes Bruno Zevi's conception of the organic as a key moment in architectural theory's move beyond formal abstraction, and an inclusion of the social sphere. John Summerson, "The Case for a Theory of Modern Architecture," *The Journal of the Royal Institute of British Architects*, 64 (1957), pp. 307–13; here pp. 308, 309.

5 Louis H. Sullivan, *The Autobiography of an Idea* (New York: Dover, 1956 [1924]), p. 258. Adrian Forty in his comprehensive chapter on the genealogy of the word "function" in architecture links Sullivan's notion to the German term "Zweck," equivalent to purpose or destiny. Adrian Forty, "Function," in Forty, *Words and Buildings: A Vocabulary of Modern Architecture* (London: Thames & Hudson, 2004), pp. 181–7. For another discussion of the numerous and diverse definitions of "function," see, for example, Ute Poerschke, *Funktionen und Formen: Architekturtheorie der Moderne* (Bielefeld: transcript, 2014).

and hippie generations alike, function is inherent to all architecture. For one, Julius Posener in his "critique of the critique of Functionalism," posited that the striving for functionality partakes in the history of social reform. [6] It is along these lines that the necessity of linking scientific, technological, and social histories of architecture has to be addressed with a "*stubbornly realist attitude*," as stated earlier in this essay.

The technological problem of noise and soundproofing is closely bound up with the social histories of housing and cities. In the late nineteenth century, noise was considered the second greatest threat to health, after odors. [7] Noise complaints increased—on both sides of the Atlantic. [8] Amid all this noise about noise, some historians tell the story that sensitivity to bothersome sounds shifted from being a bourgeois to a mass phenomenon, and thus proliferated. [9] Aspirations to privacy certainly increased, and were further invigorated by the construction industry's market launch of a growing number of insulation products. Counting complaints might give us quantitative evidence and sustain the story of raised sensitivity, yet there was no objectified method for measuring actual noise until the late 1920s. There were "noise units," "sensation units," and "transmission units," but not yet a quantified authoritative measure to say what was too loud. With units such as the Phon, introduced in Germany in 1925, and the deciBel, introduced in the U.S. in December 1928, objective measurements independent of the subjectivity and inconsistency of human perception were now at hand, and they successively paved the way for a standardized system of sound assessment. [10]

In parallel to finding an objective reference for sound intensity, a constant and controllable impulse for what was measured was needed. Thus, for testing air-borne sound (sound waves travelling through the air), sine waves of different pitches were played from gramophones. The more difficult problem was assessing impact sound (sound waves travelling through solid matter, such as a building structure, and especially the floors and the airspace below), as in the case of a neighbor's footsteps.

In 1928, acoustic specialists Vivian L. Chrisler and Wilbert F. Snyder of Washington D.C.'s National Bureau of Standards introduced a new apparatus in a research paper. This "machine for producing impact sounds" hammered steadily on the floor and thus could serve as an objective reference in various situations. [11] Chrisler, in a subsequent paper, pointed out that, "In many ways floor structures present a particularly difficult problem, as we have to deal in this case not only with air-borne noises but with impacts produced by walking or by moving furniture." [12]

6 Julius Posener, "Kritik der Kritik des Funktionalismus," *ARCH+*, 7, no. 27 (1975), pp. 11–18, here pp. 17, 15. Many thanks to Nikolaus Kuhnert, who introduced this text into my seminar's discussions of architectural criticism at the ETH Zurich in 2012.

7 Geneviève Massard-Guilbaud, *Histoire de la pollution industrielle: France, 1789–1914* (Paris: EHESS, 2010).

8 See Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, MA: MIT Press, 2002), pp. 115–68; Karin Bijsterveld,. *Mechanical Sound: Technology, Culture, and Public Problems of Noise in the Twentieth Century* (Cambridge, MA: MIT Press, 2008), pp. 159–92.

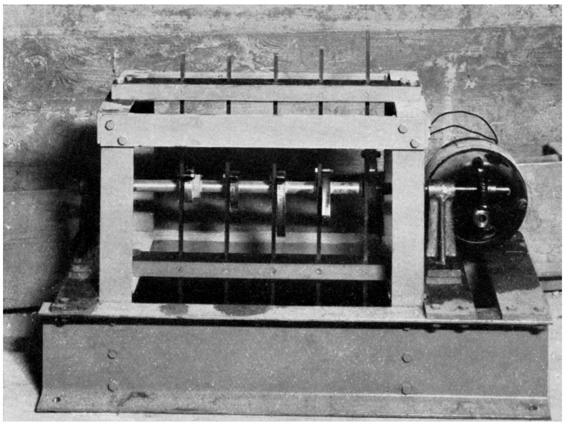
9 See Bijsterveld, *Mechanical Sound* (see note 8), p. 238.

10 Ibid., pp. 104–5; Thompson, *The Soundscape of Modernity* (see note 8), p. 158.

11 V. L. Chrisler and W. F. Snyder, "Transmission of Sound Through Wall and Floor Structures," *Bureau of Standards Journal of Research*, 2 (1928), pp. 541–59.

12 V. L. Chrisler, "Measurement of Sound Transmission," *Journal of the Acoustical Society of America*, 1, no. 2A (1930), pp. 175–80; here p. 175.

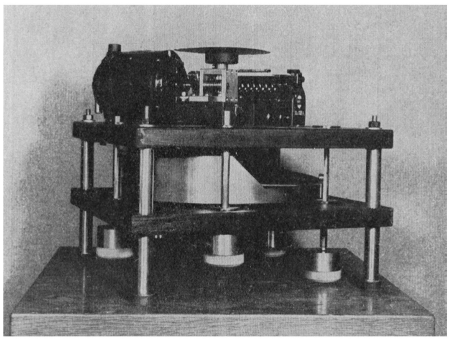
f.2 a–c "Machine for producing impact sounds" at the National Bureau of Standards in Washington D.C. (1928); the "Hammerwerk" at the Technical University Berlin (1936); the heaviest tapping machine documented at the Institution of Civil Engineers in London (1946).



Interrupting the flow of sound through a building's structure called for new concepts in engineering materials and joints. Testing sound transmission between rooms and through floors was a problem that Chrisler and Snyder would resolve: their machine "for experimenting with impact noises" featured five hammers of 500 grams each, lifted by cams and then dropped at intervals of about one-fifth of a second. [13] This weight and speed proved most suitable, although other laboratories built numerous alternatives.

A German tapping machine documented eight years later hammered at a speed of ten times per second, thus at double the speed of its American predecessor. [14] British engineers devised a tapping machine that assured 7.33 impacts per second. Here, as in the German apparatus, the hammers were arranged in a circle, yet with hammerheads of two kilograms each, making this the heaviest machine documented in the handbooks and literature consulted during my research. [15] Meanwhile, the tapping machine conceived in Goteborg, Sweden, hammered only twice per second. [16/f.2 a–c]

The National Bureau of Standard's initial setting of weight and speed later became the reference for other nation's standards of impact sound measurement, including Germany's institutionalized standard DIN 52210 and, in the process of international coordination, the international standard for building acoustics ISO 140. [17]



Today, standards internationally follow the rhythm of the American machine, but neither this nor any other of the apparatuses documented in laboratory papers disseminated in the postwar period can be heard or seen today, as none of them were deemed worthy of archival conservation. We are left with data describing the rhythms of their tapping, and with dates indicating the moment in time when building physics became a part of construction bureaucracies, at a multi-sonorous piece-rate, before their standardization. It is the noise of the many tapping machines in this narrative that draws attention to the practices brought about by regulation of the design, the construction, and the sonic performance of buildings.

13 Ibid., p. 179.

14 A. Gastell, "Schalldämmungen in der Praxis und Vorschläge zur Normung des Schallschutzes," *Akustische Zeitschrift*, 1, no. 1 (1936), pp. 24–35; here p. 29; Arnold Schoch, *Die physikalischen und technischen Grundlagen der Schalldämmung im Bauwesen* (Leipzig: Hirzel, 1937), p. 104.

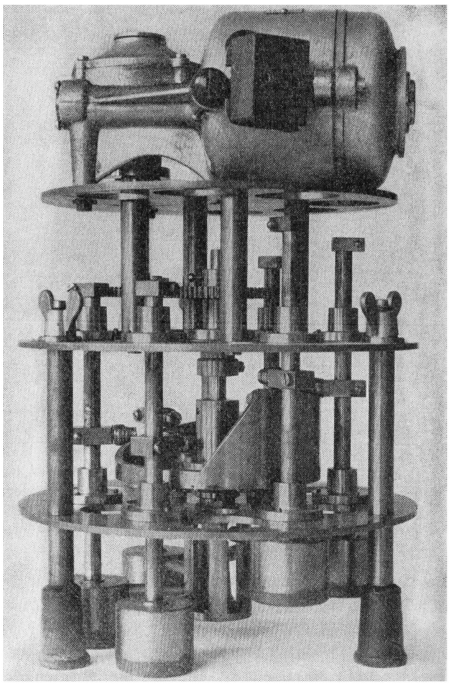
15 N. Fleming and W. A. Allen, *Modern Theory and Practice in Building Acoustics* (London: The Institution of Civil Engineers, 1946), referenced in Leo L. Beranek, *Acoustic Measurements* (New York: Wiley, 1949), p. 886.

16 Per V. Brüel and Harry K. Zaveri, "Of Acoustics and Instruments: Memoirs of a Danish Pioneer – Part 2," *Sound&Vibration* (August 2008), pp. 14–32; here p. 16.

17 For DIN 52210 ("Einheitliche Mitteilung und Bewertung von Messergebnissen") by the Deutsches Institut für Normung. For ISO 140 ("Acoustics—Measurement of Sound Insulation in Buildings and of Building Elements") by the International Standards Organization.

Steel-construction sound testing, 1936

In 1936, a group of German scientists left the laboratory to test the acoustic insulation inside a low-rise and a high-rise apartment building at the Reichsforschungssiedlung Spandau-Haselhorst. They were equipped with their equivalent of the American



tapping machine: an apparatus called “Hammerwerk.” [18] Haselhorst was the largest housing complex built under the Weimar Republic, and also a large-scale construction research project. [19] Between 1931 and 1935, 3,500 dwellings were completed. Various materials and techniques were used to build the long rows of housing in the complex, the intention being to compare these at various stages, at full scale, also once inhabited and in use. Yet the Nazis’ seizure of power in 1933 overshadowed Haselhorst’s completion, put an end to modernism, and changed the lives of its inhabitants as well as preferences in architectural form (to the extent that pitched roofs were added in the final phase), although not the modern project of assessing and standardizing architecture’s performance. The research program of testing economical construction methods was pursued throughout the 1930s, and steel frames continued to be used in some of the multi- or single-story rows of housing, also in the project’s final phase. [20/f.3] Steel frames were known to be particularly problematic for the transmission of impact sound from one unit to another in apart-

ment buildings, not only to those adjacent but also to dozens of others nearby; and so, despite being both extremely effective in structural terms and low in cost, they had to be paid close attention when it came to acoustic testing. At Haselhorst, cork sheets of 5 mm were layered between the steel frame and the brick infill, and the efficiency of this intervention was evaluated in the tests of 1936. [21]

From the very start, the Haselhorst experiment proved arduous for everyone involved. It was time-consuming to obtain all the residents’ permission to carry out noisy experiments in

18 Gastell, “Schalldämmungen in der Praxis” (see note 14), p. 29.

19 After disputes with Walter Gropius and Stephan Fischer, who had initially won the competition, the planning was put into the hands of Paul Mebes, Otto Bartning, and Wilhelm Lübbert. In order to loosen the rigidity of Gropius’s initial plan, the rows were shifted slightly off the grid and accentuated by L-shaped building heads. See Michael Bienert, *Moderne Baukunst in Haselhorst: Geschichte, Bewohner und Sanierung der Reichsforschungssiedlung in Berlin-Spandau* (Berlin: Berlin Story, 2015), pp. 31–4. Since the *Siedlung* was modern and completed after the Nazi takeover, it was never documented but rather abandoned to historical oblivion until recently, when cultural historian Michael Bienert was commissioned by the housing cooperative GEWOBAG to pull the materials from the archive. Bienert was so kind as to give me a tour of the complex, including the apartment now maintained as a “museum apartment,” in August 2015.

f.3 Steel frame construction at the Siedlung Spandau-Haselhorst, acoustically tested with the “Hammerwerk” in 1936; in the background, traditional brick construction (1930).

20 Ibid., pp. 42, 67.

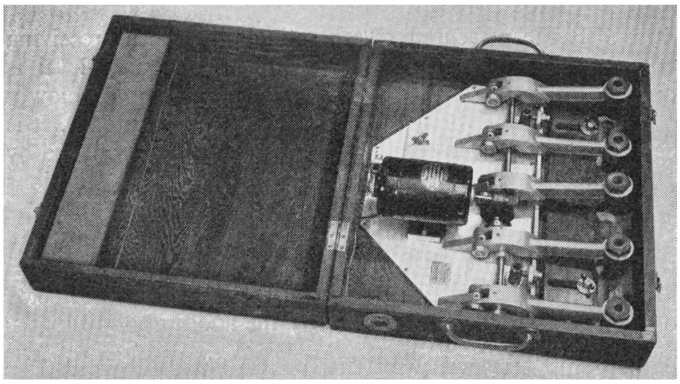
21 Gastell, “Schalldämmungen in der Praxis” (see note 14), fig. 11. Two years later, a similar test was documented for Alfred and Emil Roth and Marcel Breuer’s Doldertal buildings in Zurich. See E. Pestalozzi, “Schallschutz im Hochbau,” *Schweizerische Bauzeitung*, 111, no. 9 (1938), pp. 108–10.

their apartments. The high-pitch test tones sent through the walls hurt the residents' ears, and the hammering noises resounded throughout the building. [22] Often, the tapping machine could not be placed in the center of a room because a bed or other furniture was in the way. Especially in bedrooms, the level of sound absorption by carpets, curtains, wall coverings, bedding, and upholstery varied greatly—so much so that the results were hard to interpret, and the enormous effort of leaving the laboratory must have appeared questionable to the scientists. [23]

22 Gastell, "Schalldämmungen in der Praxis" (see 14), pp. 32–3.

23 Ibid., p. 31.

The measurements taken at Haselhorst and in other buildings in Berlin are of twofold interest in the history of architecture. Firstly, the various construction methods used there were part of the larger experiment of using steel in multistory housing construction. Secondly, the measurements were taken as test cases, to establish reference values in the standardization of tests. When new construction methods were filed for building permits, the measurements from the 1936 experiments served first as a reference and were then adopted in the second edition of "Technical Specifications for the Approval of New Construction Methods" of 1938, the DIN 4110. [24] Here, for the first time in German building regulation, the impact sound level was defined in numerical quantities, namely it was not to exceed 85 Phon. [25] The acoustic testing prescribed by the DIN regulations referred to laboratory measurements; these numerical values, however, were not released before having been tested outside of the laboratory, at Haselhorst and in other buildings in the Berlin area, at full scale, and with all the imprecisions and mishaps in planning, production, and implementation in play.

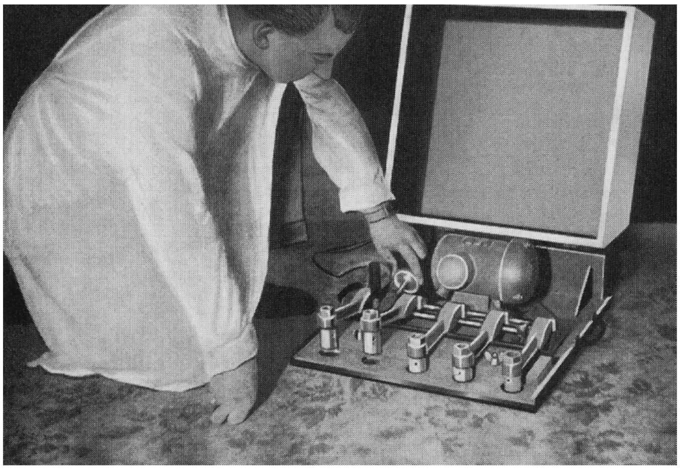


f.4 a–b Portable tapping machine for use outside of the laboratory (1952), and domesticated in the living room (1960).

Some early tapping machines could hardly be lifted, let alone be moved around in multistory buildings, outside of the laboratory. Also, housing projects under construction were usually not wired for electricity, which many such apparatuses relied on. With the growing interest in soundproofing, portable models were built. These often came with a box or case, even with a handle. Scientists now wore their clean-room suits also in the midst of homely ornament and floral carpets, and by the 1950s, the tapping machines in technical handbook illustrations appeared thoroughly domesticated. f.4 a–b In 1950, the Danish firm Brüel & Kjaer launched the first standardized tapping machine, which was nicknamed "Normtrampler" (standardized tramper) in a technical

24 DIN 4110 ("Technische Bestimmungen für Zulassung neuer Bauweisen") by the Deutscher Normenausschuss (with a circular by the Reich Minister from July 12, 1938), in *Zentralblatt der Bauverwaltung vereinigt mit Zeitschrift für Bauwesen*, 58, no. 32 (1938), pp. 879–87. The first edition of DIN 4110 by the Deutscher Normenausschuss (German Standards Committee) was published in *Zentralblatt der Bauverwaltung vereinigt mit Zeitschrift für Bauwesen mit Nachrichten der Reichs- und Staatsbehörden*, 54, no. 9 (1934), pp. 563–8. Here, soundproofing was defined relative to common brick walls, without numerical values. For a longer discussion of acoustic regulation in Germany and Switzerland, see Sabine von Fischer, "Dynamique ou uniformisation? À propos de la normalisation dans la conception de projets et l'industrie du bâtiment, à travers l'exemple de la réglementation acoustique," *Matières*, 12 (2015), pp. 116–31.

25 DIN 4110: 1938 (see note 24), p. 887.



handbook. 26 Its domestic-looking wooden casing, a design still in use today, also falls into the category of those “archaic objects” often used to reconcile new technology with the familiar. 27 At the same time, the human activity of loud footsteps was translated into mechanical movements and technical standards, a kind of early sound-making yet non-hearing man-machine. Acoustic devices for architectural testing were designed with the utmost possible exclusion of experience in mind. These loud, penetrating devices reduced sound to a physical impulse stripped of any variation in pitch, timbre, and rhythm. The only intended recipient of these sounds was the measuring apparatus, which after 1930 was no longer the human ear.

The logic of the laboratory posed further problems in the world outside, where the tapping machine was taken as a universal reference in assessments of the transmission of (mostly unwelcome) sounds. These unchanging hammering sounds differed from the widely diverse noises likely to cause conflicts between neighbors, to say nothing of the many different types of footstep, from bouncing heels to scuttling toes. Thus, the tapping machine was repeatedly compared to different types of male or female, soft or hard-heeled footsteps, and Karl Gösele, the leading German expert on impact sound transmission, concluded in his research report of 1957 that some flooring materials performed better in respect to their soundproofing capacity when tested with standardized hammer heads, others when walked on by real people. 28

Considering that the sole of a shoe and the mood of a person altered the quality of impact sounds, what about screeching chairs, rattling dishwashers, droning vacuum cleaners, and plummeting children’s toys? Despite, and equally because of this reduction of the world of noises to a standard of five hammer heads of 500 grams each, the tapping machine’s beating in a 1967 study was deduced to be a “very practicable compromise, … because sounds are not only produced by walking and running, but also by knocking, and when things are dropped.” 29

26 Werner Bürck, *Die Schallmessfibel für die Lärmbekämpfung* (Mindelheim: Sachon, 1955), p. 64.

27 Adrian Forty coined the term “archaic objects” for radios concealed within antique furniture in the 1920s as a “resistance to the newness of things.” Adrian Forty, *Objects of Desire: Design and Society since 1750* (London: Thames & Hudson, 1986), p. 11.

28 Karl Gösele, *Zur Messung und Beurteilung des Trittschallschutzes* (Stuttgart: Forschungsgemeinschaft Bauen und Wohnen, 1959), p. 26.

29 L. Cremer and M. Heckl, *Körperschall: Physikalische Grundlagen und technische Anwendungen* (Berlin: Springer, 1967), p. 295 (My translation).

The ear revisited, 1956

Concerns in architectural acoustics were deeply entangled with the tasks of granting privacy and enabling communication in dwellings and workplaces. Testing, assessing, and comparing the sonic performance of buildings relied in part on quantification of the residents' acoustic experience of these dwellings and workplaces. Thus, acoustic testing and standardization came with a certain tension between method and aim: while the aim was to improve the comfort of living and working, the methods themselves excluded human experience. The human presence and the senses were in conflict with the method's quest for objectivity.

Until circa 1930, acousticians such as Wallace C. Sabine at Harvard University, Vivian Chrisler at the Bureau of Standards, or Harvey Fletcher of Bell Laboratories determined by listening whether a sound was louder, equal, or less audible than a given impulse, a method that was "laborious, very tiresome for the observer, and depended upon the observer's ability always to stop the watch just as the sound disappeared." 30 As of 1928, once the impulses of the tapping machines hammering onto floors had been standardized, the scientists resented even more the fact that individual human hearing was still part of the measuring process. Sound was under scrutiny to the extent that its measurement could no longer depend on human sensation. Soon afterwards, sound measurements came to be taken automatically, and the physicist's listening presence was no longer required. But, as I will show, human hearing did reappear in acoustic testing.

f.5 Lothar Cremer's "Vergleichshammerwerk," a comparative device for the simple on-site assessment of sound transmission (1957).

30 V. L. Chrisler, "Acoustical Work of the National Bureau of Standards," *Journal of the Acoustical Society of America*, 7, no. 2 (1935), pp. 79–87; here p. 83.

In the postwar period, with the proliferation of soundproofing technologies and regulating standards, a faster, easier, and simpler method for testing wall and floor constructions was called for. Outside the laboratory, on-site, things needed to be practicable. Lothar Cremer, Europe's most renowned twentieth-century acoustician, repeatedly demonstrated an affinity for, if not insistence on, listening practices, as did many of his fellow acousticians—despite the fact that the human ear had been excluded from objective scientific methods. Listening came in

handy when engineers were looking for a simpler method. Cremer, who is best known among architects for his collaboration with Hans Scharoun on the Berliner Philharmonie in 1956, collaborated that same year with the German housing secretary Bernhard Wedler on a campaign for better sound insulation in residential buildings. Wedler had formerly been responsible for construction regulations, including the DIN 4110 of 1938, for testing new construction methods, and the DIN 4109 of 1944, which dealt solely with sound insulation in buildings, and he stands out as an engineer and administrator who engaged deeply with the acoustic qualities of buildings. 31

In 1957, the Ministry of Housing printed 100,000 copies of his brochure *Baut ruhige Wohnungen* (Build Quiet Apartments). 32 Around the same time, he produced an educational film, for which Cremer provided the script. 33 The 1957 brochure features a "simple apparatus for estimating … impact sound insulation," which Cremer had devised with his collaborators, and which operated on the basis of comparing, by ear, the sound transmission from the room above with the sound emission of this simple apparatus. 34/f.5/f.6

Acoustic standardization brings with it larger questions: Can a technical standard implement a social regime of noise control—or is it rather that the social regime legitimates the rule, which in itself has no normative power? In the case of technical standards, any normative level is arbitrary and thus artificial, as French philosopher of science Georges Canguilhem argued. 35 And yet, the issue of soundproofing and privacy was fought over so vehemently during the twentieth century that one might arguably consider acoustic standards to be valid indicators of social norms as well as agents in the process of defining them. 36 When is a noise

f.6 Information brochure for architects, issued by the German Ministry of Housing (1957).

31 DIN 4109 ("Richtlinien für den Schallschutz im Hochbau") by the Deutscher Normenausschuss (1944, single sheets reprinted in January 1959 on the occasion of a revision, annotated in December 1960). From the private archive of Dr. Joerg Wildoer, Genest AG, Berlin.

32 Bernhard Wedler, *Baut ruhige Wohnungen* (Bad Godesberg: Bundesminister für Wohnungsbau, 1957).

33 Lothar Cremer, *Schallschutz im Wohnungsbau* (Munich: Institut für Film und Bild in Wissenschaft und Unterricht, c. 1953), approx. 15 mins.

34 Manfred Heckl and Heinz Westphal, "Einfaches Gerät zur Abschätzung des Trittschallschutzes (Vergleichshammerwerk)," *Bundesbaublatt*, 9 (1957), pp. 458–61. An exemplar of such a comparative tapping machine ("Vergleichshammerwerk") was standing in a corner at the acoustic testing facility of the Technical University Berlin when I visited there in 2009, without anyone being able to tell me what it was for. The filing record was stamped: "To be discarded." Nevertheless, the newly identified machine aroused the interest of the engineers who today are equipped with maximum precision instruments and yet still rely on what their own ears hear. A restaging of the test situation at TU Berlin in June 2015 confirmed the practicality and yet the arbitrariness of such simple auditory assessment by the human ear.

35 Canguilhem elaborated the notion of "vital" and "social" norms versus "technical" standards: Georges Canguilhem, *The Normal and the Pathological*. Trans. Carolyn R. Fawcett (New York: Zone Books, 1991 [1966]), pp. 237–56. See Henning Schmidgen, "Über Maschinen und Organismen bei Canguilhem," in Georges Canguilhem, *Wissenschaft, Technik, Leben: Beiträge zur historischen Epistemologie* (Berlin: Merve, 2006), pp. 157–78; here p. 171.

36 See Sabine von Fischer, "Dynamique ou uniformisation?" (see note 24).

too loud? Is there a democratic norm for loudness, or does the right to noise stand for privilege and power, whereas the powerless are subject to a rule of silence? [37]

Wedler's brochure of 1957, as well as further literature related to building regulations, promoted the "Vergleichshammerwerk" (comparative tapping machine), despite the fact that objectivity was assumed in the 1950s to be a prerequisite of any technical science or engineering operation. This manually operated tapping machine used to assess sound insulation with the help of the human ear, by hearing the difference in loudness between two rooms, weighed 12 kilograms and cost 380 DM. [38] Together with the "Norm-Hammerwerk" (standard tapping machine), weighing 15 kilograms and costing 450 DM, impact sound measurements could be taken on site without the use of heavier and more expensive electronic equipment. Including the ear was justified by the practicality of easier handling and simple and quick measurements even by laymen. At the nexus of the technical and the social, a testing apparatus dependent on human hearing seemed acceptable to both technicians and the building administration and was therefore introduced into the otherwise mechanical, automated, and standardized practice of architectural acoustics.

Cremer's "comparative tapping machine" confronts us with the paradox of putting mechanical expertise at the service of everyday functionality and comfort in domestic and working environments. It illustrates how the inclusion of a perceiving organ in the practice of sound measurement resulted in the latter's exclusion from science's normative standards. Cremer's device is not mentioned again in the literature of the following decades, nor does anyone recall an event of its use. [39] It remains a forgotten episode, in which the scientific methods of architecture were tested for their capacity to include the listening ear as part of the apparatus for assessing a building's functionality. The use of tapping machines to test a building's acoustic performance replaced the everyday nuisance of bothersome noises by an objectively quantifiable level of loudness, which then could be measured against a technical standard. With the advent of automation and standardization, the hearing ear was excluded from acoustic testing. These endeavors in scientific enquiry were undertaken in behalf of bodily health and comfort; and yet, episodes of reintroducing hearing into the evaluation of sound, such as Cremer's "Vergleichshammerwerk," remained of little consequence and were soon disremembered. This leaves us with the question as to whether the tapping machine as an architectural device is related to the presence, or to the absence, of experience.

37 See Mark M. Smith, *How Race is Made: Slavery, Segregation, and the Senses* (Chapel Hill: University of North Carolina Press, 2006).

38 Bernhard Wedler, *Berechnungsgrundlagen für Bauten*, 23rd ed. (Berlin: Ernst, 1959), p. 440.

39 As revealed by questions I put to the older collaborators at the acoustics department of the Technical University of Berlin in June 2009 and June 2015, as well as by the collections in German museum archives.