THE SOUNDSCAPE OF MODERNITY

ARCHITECTURAL ACOUSTICS AND THE CULTURE OF LISTENING IN AMERICA, 1900–1933

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inclined at just the right angle to reflect the sound out toward the audience on the upwardly sloping grounds. Knudsen's goal was to provide "a pronounced directional flow of sound toward the audience," to ensure that the "myriads of attentive people" gathered in the bowl could all hear clearly and distinctly.[81] Considering that the bowl held as many as twenty thousand attentive listeners, and that those in the most remote seats sat over five hundred feet away from the musicians on stage, achieving this goal was a considerable challenge.

While some criticized the new shell, complaining that certain seats still received insufficient or unbalanced sound and that the transite and steel arches resulted in "metallic and strident" tones, it was nonetheless celebrated for its "utterly echo-less and amplifying traits."[82] "The faintest tones of the violin are clearly audible in the most remote seats," one reviewer claimed, adding, "The acoustics of the Bowl are enthusiastically praised by musical critics."[83]

The sound of the Hollywood Bowl, with its pronounced directional flow and its echoless and amplifying traits, constitutes another example of the modern sound that was now being presented to auditors by auditoriums, amphitheaters, and loudspeakers alike. Hollywood would increasingly be associated with this new sound, but not via its connection to the Hollywood Bowl, nor to any other venue for live music. Hollywood was the headquarters of the motion picture industry and it was within the walls of the motion picture theater that most Americans were exposed to the new sound.

IV Architectural Electroacoustics: Theater and Studio Design

The silent cinema had never really been silent; it had always been filled with sound.[84] Kinetoscopes were viewed amid the clatter and din of the amusement parlor, and the earliest theaters for projected motion pictures were just as noisy and chaotic. Many people saw their first projected films as part of the bill of fare at a local vaudeville theater. Others viewed them in makeshift storefront theaters leased by itinerant showmen. A draped sheet served as the screen, and folding chairs were the extent of accommodation. In spite of such spartan surroundings, the excitement of seeing something new packed these houses night after night. By the turn of the century, when it was clear that the movies were more than a fad, exhibitors began to set up more permanent facilities and accommodations gradually began to improve. Nondescript storefronts were transformed into alluring portals to paradise with prefabricated facades of sculpted terra cotta or

stamped tin, gaudily festooned with electric lights. Interiors were enhanced, and architectural journals began to publish guidelines for seating arrangements, sight lines, ventilation, projection booth layout, and other aspects of motion picture theater design.[85]

As attention to architectural accommodations increased, so, too, did that paid to the provision of music in the theater. The monotonous din of a player piano had filled the storefront cinemas with sound, but patrons now expected more for their price of admission. Some exhibitors included live musical acts as part of the show. The audience itself contributed, too, when illustrated song-slides were projected to guide sing-alongs of sentimental favorites.[86] Finally, music to accompany and enhance the material depicted on screen became an integral part of the program. Local pianists improvised scores in the smaller houses, while larger theaters employed an organist or a small orchestra. Musicians fortunate enough to work in houses featuring powerful Wurlitzer or Marr & Colton organs could create different sounds and moods with the push of a button or the pull of a stop. These instruments additionally provided an arsenal of sound effects, from bells and sirens to gunshots.[87]

Still, the early-twentieth-century motion picture theater hardly encouraged rapt, attentive listening. The program of numerous short films ran continuously, and audience members came and went, constantly and noisily, throughout the program.[88] The music was often raucous, inappropriate, or both.[89] As the creative ambitions of producers and exhibitors grew, however, this situation would change. On the production side, the short one-reelers grew into multireeled features that could last two hours or longer. Rich character portrayals and complex stories now unwound along with the celluloid, drawing the viewer into an increasingly compelling world of fantasy. Producers began to invest heavily in elaborate stage sets and exotic on-location shooting to achieve an unprecedented degree of spectacle on screen.

As the films themselves became more sensational, so, too, did the theaters in which they appeared. "Picture palaces" in the larger cities rivaled the on-screen spectacles for extravagance, offering their patrons richly upholstered seats, smoking lounges, and liveried attendants in addition to the entertainment that appeared on screen. Throughout the teens and twenties, architects like Thomas Lamb, Rapp & Rapp, Meyer & Holler, and John Eberson created Chinese pagodas, Egyptian temples, and Italian villas out of stucco, plaster, velvet, and gilt. Perhaps the most fantastic were the "atmospheric" theaters of Eberson. Here, the screen was surrounded by a stage-set-like construction that created the effect of

a Mediterranean garden, a Middle Eastern village, or some other exotic outdoor locale. The theater was surmounted by a smoothly curving plaster ceiling that, while plain in itself, was illuminated during the show with rich blue hues to effect a night sky. Special light projectors wafted clouds and twinkling stars across the heavens to complete the illusion.

The managers of these picture palaces, men like Sid Grauman in Los Angeles and Roxy Rothafel in New York, took pride not just in their architectural surroundings, but also in the elaborate live productions that showcased the films they exhibited. Organ preludes, orchestral overtures, guest soloists, and elaborate "ballets" opened each night's program. Regal musical directors like Rouben Mamoulian and Hugo Reisenfeld not only led large orchestras of talented musicians, but also composed and compiled unique scores to accompany each new feature film.

Of course, only a small number of theaters in large cities could offer such musical amenities. Still, there was a "trickle-down" effect that improved the quality of music offered in more typical neighborhood theaters. Famed music directors published guidebooks that helped less-talented musicians create effective accompaniments to films.[90] As individual exhibitors expanded their theatrical empires into regional and national chains, the musical resources of their first-run flagship theaters became available to their less urbane second-run houses. Film scores were passed along, and in a few cases, the live productions actually became road shows that traveled into the hinterlands along with the feature films they showcased.[91]

Producers as well as exhibitors worked to improve the quality of music in the theaters. As early as 1909, the Edison and Vitagraph Companies had offered suggestions for music to accompany their films. With the rise of the feature film, production companies began to provide detailed cue-sheets, not only suggesting songs or themes, but also indicating the precise points in the film at which these themes should enter and exit. For the most significant features, a complete and original musical score was commissioned and distributed to exhibitors.[92]

In spite of the increasing attention paid to music, little such attention was paid to the acoustics of theaters until the arrival of sound film in the late 1920s. Floyd Watson noted that "the necessity for adjusting the acoustics of theaters has not arisen so often nor so seriously as in the case of churches and other auditoriums," and the published record confirms his conclusion.[93] The earliest articles on theater design said little, if anything, about acoustics.[94] Roxy Rothafel's experiments with his P.A. system in the early 1920s suggest that, in the largest

houses, it may have been difficult to produce a volume of sound sufficient to reach all seats, but this problem was not significant enough to provoke discussion in articles and guidebooks on theater architecture. With the advent of sound movies, however, all this would change.

"The telephone rings. 'Long distance calling. Smithtown, Palatial Theatre. New installation of talking picture a failure owing to bad acoustics. Advice necessary at once or house must close.'" "Such," declared acoustical consultant Clifford Swan, "is the typical S.O.S. call for help."[95] By 1929, according to Swan, the problem of acoustics had become "insistent," as previously silent theaters, in which "the question of hearing was not a matter to consider," were wired for sound.[96] Countless theaters across the nation were suddenly discovered to be acoustically deficient, and consultants like Swan found a wide new field in which to exercise their expertise.[97] As one observer put it, "The film being no longer silent, the acoustic expert must be heard."[98]

The film industry initially turned to academic consultants like Watson and Knudsen, or to men associated with the acoustical materials industry like Swan, to provide that expertise. But the companies that manufactured and sold the electroacoustic sound film systems soon undertook to obtain that knowledge for themselves, and before long, acoustical consulting became yet another of the many sound products they offered for sale.

The first and foremost of these organizations was Electrical Research Products Incorporated (ERPI), the company that leased, installed, and serviced the Western Electric sound picture systems. ERPI was a wholly owned subsidiary of Western Electric established in January 1927 to handle this new business. The original personnel was recruited largely from Western Electric and AT&T, but the company grew rapidly and incoming classes of sales and service engineers came not only from the Bell System, but also from radio manufacturers, power and light companies, and other related industries.[99]

Initially, the electrically minded ERPI engineers focused their attention upon the sound equipment itself, and architectural acoustics was mentioned only briefly in the instruction provided to new installation engineers.[100] But it quickly became clear that acoustical expertise was required to ensure a successful installation, and in February 1929, training instructor S. K. Wolf was reassigned to the theater engineering group to lead research in architectural acoustics. Wolf traveled to the Riverbank and Burgess Laboratories to study firsthand the "latest developments in the field of acoustical research."[101] He hired academic acousticians as well as experts from the building materials industry, and by October his

technical staff of nine had not only begun numerous fundamental investigations but had also analyzed, and recommended alterations to, over 300 theaters. Several of the large theater chains arranged to have Wolf's staff examine all of their plans for new theaters, and prominent theater architects also availed themselves of this ERPI service. By December, Wolf's men were reviewing the acoustics of 75 theaters, old and new, every week.[102]

Most of ERPI's work on theater acoustics was dedicated to rendering the old, so-called silent theaters suitable for the new sound equipment. The acoustical survey became an integral aspect of the work of ERPI installation engineers stationed across the nation and around the world. The company newsletter, *Erpigram*, explained the procedure:

> A complete acoustical survey of the theatre is first made by the Installation engineer who is assigned to make the regular survey. Written reports of this survey are then sent to the acoustic engineers in the home office [Wolf's group] who analyze them to determine the acoustic values of the house, and to draw up recommendations for treatment when needed.
>
> In making the surveys, engineers are required to determine the exact volume and seating capacity, nature and thickness and amount of draping and decorating material used in the theatre, exact nature of all seats and furniture, etc. Also included is a noise survey and recommendations for eliminating all noises in the house. So complete is this survey, the report covers five pages and either accurate sketches or architects' drawings must be included in the survey reports.[103]

ERPI engineers, outfitted like big game hunters or members of some expeditionary force, "went on the warpath with a full complement of weapons to banish the bogy Silence and his near relation General Reverberation." "Each man," the *Erpigram* explained, "has been supplied with a large fibre knapsack in which to carry his equipment. Among other things, it contains a steel tape so that he may measure a house, and the structure with which he comes in contact will have to be analyzed for hidden horrors, such as 'plaster backed by brick,' [and] 'leather covered seats, filled with straw.'" The kit also contained a cap pistol, to "hunt out Reverberation, and his Echoes, and banish him from the theater."[104]

It was immediately evident that the problem in the old theaters was too much reverberation. The metropolitan movie palaces may have suffered less in spite of their large size, as their drapes, carpets, and well-stuffed upholstery would have created an absorbent environment, but, as Clifford Swan noted, the majority of theaters were "mere barren halls with plaster walls and ceiling, wood

or concrete floors, and bare wood seats."[105] The audience itself provided the only significantly absorptive surface, and the ERPI engineer called upon to correct such houses would "eagerly watch the door, and every time an additional person enters optimistically mutter to himself, 'Here comes four and seven-tenths units more.'"[106]

If it was clear that too much reverberation was plaguing sound movie theaters, it was not immediately obvious what constituted an optimal reverberation time for these rooms. All previous research, dating back to Wallace Sabine's experiments at the New England Conservatory of Music, had considered only live music and speech. The technology of sound reproduction fundamentally changed the situation, and one of first tasks undertaken by Wolf's group, as well as by others, was to reevaluate the role of reverberation and to determine new optimum reverberation times for rooms that were wired for sound.

In 1930, a researcher at the acoustical laboratory of the General Electric Company discussed "Some New Aspects of Reverberation" before the Society of Motion Picture Engineers. Edward Kellogg identified three primary contributions of reverberation to the acoustics of live-performance spaces: It served to build up and thus increase the total volume of sound in the room; it mixed the elements of sound present at any given instant (for example, the various instruments of an orchestra); and it caused sounds produced sequentially in time to overlap with each other. The first two functions were beneficial and the last, Kellogg asserted, was strictly detrimental. Traditional prescriptions for optimal reverberation times for auditoriums thus were a compromise between the good and bad roles that reverberation played.[107]

In auditoriums that were wired for sound reproduction, however, no such compromise was required. An appropriate level of loudness could be achieved simply by adjusting the gain of the amplifiers. Proper positioning of the highly directional loud speakers further ensured that listeners located in even the most distant seats would receive a sufficient volume of sound. Nor was reverberation required to mix or blend the sounds; this mixing, Kellogg pointed out, was already accomplished during the recording process. The only role left for reverberation was to cause the overlapping of sounds, a role best eliminated. "So far as we can see, then," Kellogg concluded, "there is practically nothing which auditorium reverberation accomplishes which cannot be secured in a highly damped auditorium by other means," and Kellogg recommended that auditoriums for reproduced sound should be designed with maximum possible absorption. In other words, his optimum reverberation time was zero.[108]

Kellogg's pronouncements were extreme, but his conclusions differed from others' only in degree, not substance. S. K. Wolf, too, emphasized that the electrical amplification of sound rendered unnecessary any dependence on reverberation to achieve sufficient loudness. He also noted that the presence of studio reverberation on the recording itself decreased the need for theater-generated reverberation. Both factors indicated that optimum reverberation time in theaters for sound reproduction be considerably lower than that for live performance spaces, and Wolf recommended a difference of about 0.25 seconds.[109] Actual recommendations ranged from about 1.25 seconds for a theater of 175,000 cubic feet (a seating capacity of around 1,200 people) to 1.75 seconds for a theater of 1,000,000 cubic feet (the very largest, with a capacity of about 6,000 people).[110]

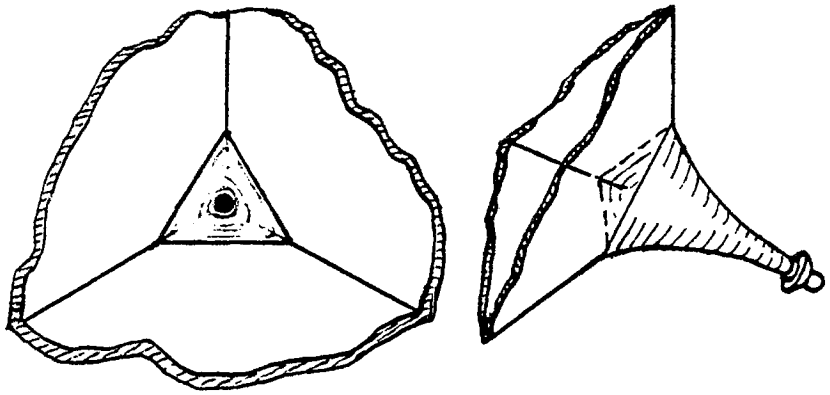
Even if reverberation in theaters were only to be reduced and not eliminated, that reduction was still significant. The rooms were generally overreverberant to begin with, and the goal was now to reduce the reverberation time to as little as one second.[111] To bring about this transformation, large quantities of sound-absorbing materials were introduced. Upholstered seats were chosen to effect the same absorption as the people who filled them, so that reverberation would remain constant whether the house was full or not. Drapes and tapestries were hung in some theaters, acoustical plasters were applied in others, and sound-absorbing materials like Celotex were installed on walls and ceilings just about everywhere.[112] The cost of "correcting" a motion picture theater could be considerable, and this cost was in addition to the expense of acquiring the sound equipment itself. While large theater chains could absorb these expenses, independent operators were hard-pressed to finance such expenditures. As a result, the already declining role of the independent exhibitor in the motion picture industry declined even further.[113]

In theaters that were successfully altered, the sound was "beamed"[114] directly out at the audience by highly directional loudspeakers located up front, typically behind the screen. This sound had much in common with the electrical signal that was its source. As theaters were wired for sound, the distinction between the architectural space of the auditorium and the electrical circuitry that transmitted the signal into that space began to fall away, until it ultimately became difficult to determine where the signals ended and the sounds began.

ERPI engineer G. T. Stanton, for example, defined the motion picture auditorium as "a system for transmission of sound." As he described it, the theater was fundamentally no different from the telephone, radio, or any other such sys-

tem, and his criteria for evaluating auditorium performance were the same as for those electrical systems. To Stanton, the sound—whether in the circuits or in the architectural space of the theater—was a signal, a carrier of information whose goal was to arrive efficiently and accurately at its final destination.[115] For Edward Kellogg, the architectural and electrical systems merged in ways not just conceptual. In 1931, Kellogg proposed a new type of theater loudspeaker in which the speaker driver was to be mounted in the corner of a room, and the three surfaces of the room that emerged from that corner would serve as the horn of the speaker. The room itself thus became the loudspeaker's horn, as architecture and electroacoustic technology merged seamlessly into one continuous system of transmission.[116] (See figure 6.12.) While architectural acoustics and electroacoustics began to merge, physically and conceptually, in the sound motion picture theater, that merger would occur even more dramatically in the sound studios.

Recording studios date back to the origins of phonographic recording, but here, too, little attention was paid to room acoustics until electricity entered the scene. With preelectric, or acoustic, recording, musicians were placed as close as possible to the horn that collected their sounds and channeled them to the



6.12
The convergence of architectural acoustics and electroacoustics is demonstrated in Edward Kellogg's design for a loudspeaker whose horn was to merge with the walls of the room in which it was installed. Reprinted with permission from Edward W. Kellogg, "Means for Radiating Large Amounts of Low Frequency Sound," *Journal of the Acoustical Society of America* 3 (July 1931): 106. © 1931, Acoustical Society of America.

recording apparatus. Solo performers stood directly in front of the horn. Small ensembles of musicians were necessarily further away, but still crowded as proximately as possible. Larger groups, such as symphonic orchestras, were virtually impossible to record successfully.[117] The goal of acoustic recording was to capture as much of the direct sound energy of the performance as possible, and there was little discussion about capturing (or eliminating) the sound of the studio itself. Extant photos and drawings of early recording studios offer little evidence of any significant effort to control the acoustic character of the rooms. Recording quality was controlled primarily through the selection of different sizes and shapes of horns, and through the arrangement of musicians with respect to the horn.[118] (See figure 6.13.) With the advent of radio broadcasting in the early 1920s, however, and with the electrification of phonographic recording, the acoustic properties of the studio suddenly became significant.

Microphones immediately freed the musicians in the studio from the cramped spatial arrangements that acoustic recording had necessitated. Now, electrical amplifiers ensured adequate sound intensity. An appropriate balance between instruments was achieved not through the awkward placement of musicians, but through the use of multiple microphones and mixing consoles in which the signals from those microphones were blended and balanced electrically. If the physical space of elbow room was no longer a problem in the electrified studio, however, acoustical space was. The earliest microphones were omnidirectional, "listening" in all directions at once. They thus captured the reflected as well as the direct sounds of the musicians, and electrical recordings therefore included the reverberatory character of the studio to a degree that acoustic recordings had not.

Some perceived this new characteristic as a move toward greater realism and fidelity; it made a record sound more like a live performance heard in a concert hall. Others were troubled by the layering of different acoustical spaces that occurred when recorded reverberation was reproduced in a room that additionally contributed its own acoustical character. Even proponents of recorded room sound realized that a little reverberation went a long way, however, and electrified studios were soon swaddled with sound-absorbing materials.[119] (See figure 6.14.)

In 1928, Paul Sabine recalled that the "early practice" in electroacoustic studio design had been "to cut down sound reflection to the limit." "Gradually," he noted, "the tendency toward less deadening and longer reverberation times has grown up." But "longer" was clearly a relative term here; Sabine described an

6.13
Acoustic recording session at the Edison studio in New York City, 1912. The differently shaped horns on the wall and floor were used to control the quality of the recording. The recording phonograph, not visible here, was located behind the barrier at the far left of the image. Musicians were arranged in space to balance their sounds on the recording. The black partitions may have been covered with sound-absorbing material, but such materials were not widely used in acoustic recording studios. United States Department of the Interior, National Park Service, Edison National Historic Site.

6.14
The KDKA broadcast studio in Pittsburgh, heavily draped for sound absorption. A microphone hangs from a boom to the right of the piano. One wonders if the creaking of wicker rocking chairs created problems for the sound engineers who worked here. D.G. Little, "KDKA: The Radio Telephone Broadcasting Station of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pennsylvania," *Proceedings of the Institute of Radio Engineers* 12 (June 1924): 273.

experiment he had carried out for radio station WLS in Chicago in 1926, to find out what conditions were preferred by listeners. An identical program was broadcast three times from a studio whose reverberation was varied from 0.25 to 0.64 seconds. While the listeners indicated a preference for the program with the greatest amount of reverberation, that amount—just 0.64 seconds—could hardly be considered "live."[120]

Joseph Maxfield, too, was a proponent of recorded room sound, particularly for recordings of orchestras, where reverberation constituted part of the "musical and artistic effect."[121] Nonetheless, Maxfield argued that a studio for recording should still be considerably less reverberant than a room intended for listening to live performances. He explained that extra damping was required to compensate for the fact that the monaural microphone in the studio detected sound differently from the binaural human listener. The "one-eared" microphone perceived more reverberation in a given space than did a two-eared person; thus the absorptivity of a space had to be increased so that the recorded signal would not sound excessively reverberant when later heard by human listeners.[122] As acousticians like Watson and Knudsen were lowering their recommendations for optimum reverberation in live performance spaces, and as theater consultants like Wolf were recommending reduced reverberation in spaces for the reproduction of sound, studio consultants were recommending even less reverberation for the spaces in which sound was recorded. Other than the soundproof, anechoic laboratories that were constructed for scientific research, these studios were the most absorptive spaces around, with recommended reverberation times falling well below one second.[123]

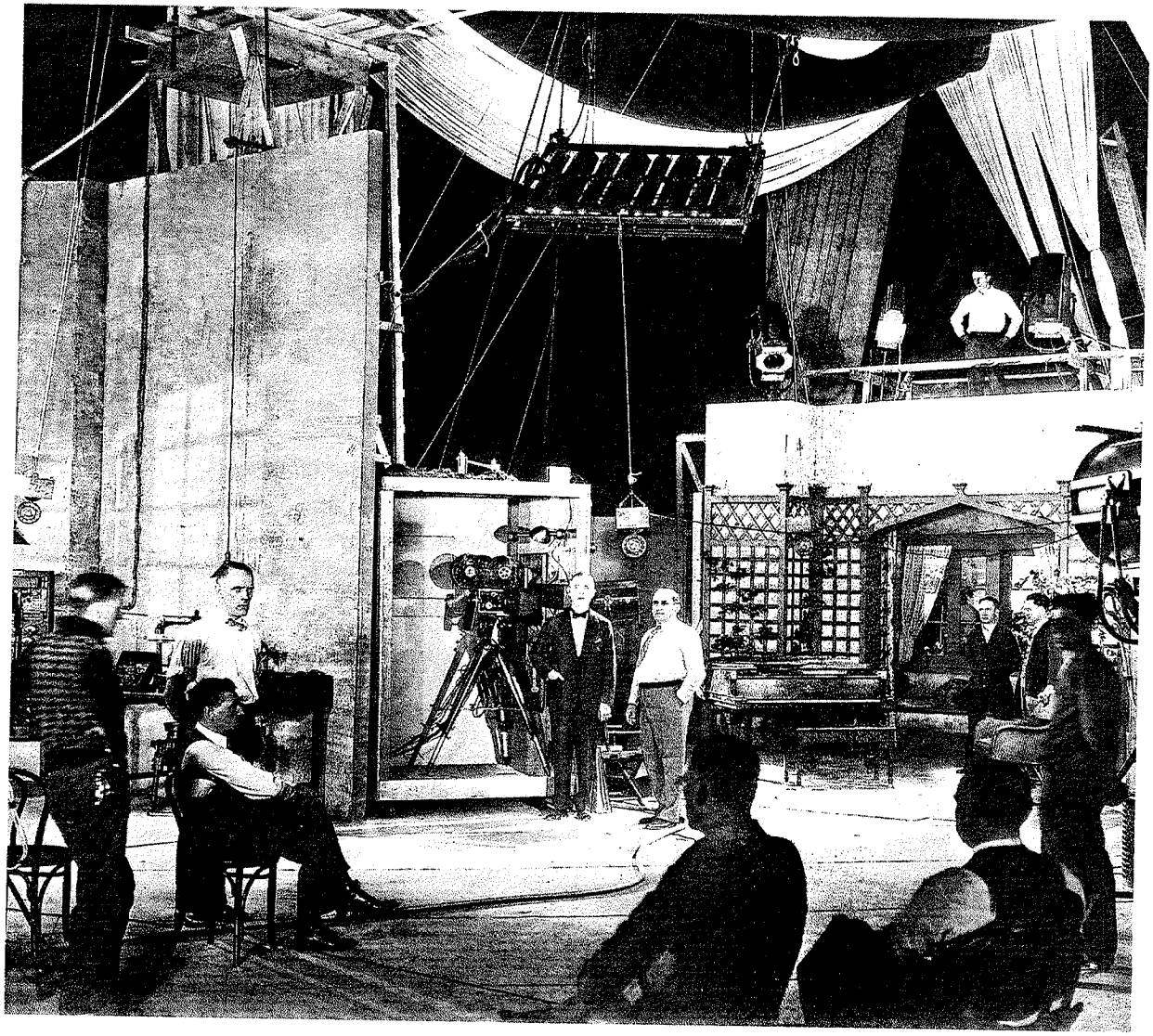
In addition to eliminating virtually all of the reverberatory sounds within the studio, it was just as critical to keep extraneous noise out. In 1928, the new NBC studios in New York exemplified state-of-the-art design for sound absorption and isolation. The problem of broadcast studio design was, as architect Raymond Hood put it, "as modern as a problem could be." "About the technical side there could be no discussion. We were to work with their engineers to make the studio as sound-proof and as acoustically perfect as possible."[124] The NBC studios employed floating construction in which the walls, ceilings, and floors were all mechanically isolated from the surrounding structure to prevent the transmission of sound.[125] Observation windows were double- and triple-glazed, and heavy doors were lined with airtight rubber gaskets to create a "hermetically sealed"[126] environment. If the hermetic seal evoked in advertising for the PSFS Building had been metaphoric, the term was applied far more literally

to the new electroacoustic studios. In such airtight surroundings, artificial ventilation was a necessity, and the requisite air-conditioning systems were carefully designed for silent operation. All machinery was kept distant from the studio site and mechanically isolated, and air ducts were lined, inside and out, with sound-absorbing materials so that noise would not travel into the studios along with the cool air.

By 1928, just as the challenge of broadcast studio design appeared to have been successfully met, an even greater challenge arose. Studios for sound motion pictures required an even greater degree of acoustical control. They had to provide this control in a much larger space, and they had to do so in a way that did not interfere with the visual aspects of film production. While soundstage designers could thus draw upon the principles of design developed for radio and phonograph studios, distinctly new problems had to be addressed.

The first Vitaphone production facility was the old Vitagraph motion picture studio in Brooklyn. Warner Brothers had acquired the property in 1925 and they chose to begin their experiments with sound here, close by the scientists and engineers at Bell Laboratories. The need for a soundproof location, isolated from the noises of the city, was quickly made evident, but little could be done here except to record at times when such noise was at a minimum. The first sound recordings made in the Vitagraph studio also suffered from distinct echoes and excessive reverberation, so carpets were taken out of the prop room and heavy cloth was draped around the set to absorb as much sound as possible.[127]

Vitaphone soon relocated to the Manhattan Opera House, Oscar Hammerstein's old theater on 34th Street at 7th Avenue, and the musical shorts that premiered with *Don Juan* were produced here, as was *The Voice from the Screen,* a documentary produced for the New York Electrical Society by Bell Labs to explain and demonstrate the new sound pictures. As at the Vitagraph studio, city noises intruded and the theater was draped to reduce its reverberation.[128] (See figure 6.15.) When other motion picture producers entered the sound scene, they, too, established facilities in or near New York, to be close to the voices of Broadway and the Metropolitan Opera, as well as the sound engineers in Manhattan and New Jersey. By 1927, however, Warner Brothers had already begun to relocate its operations to new soundstages in Hollywood, and the other studios soon followed. By 1929, virtually all of the major producers were building new studios in and around Los Angeles, and they depended on acoustical experts to ensure that these structures were both soundproof and nonreverberant.[129]



6.15
Recording a Vitaphone sound motion picture in the Manhattan Opera House, New York, 1926. This photo was taken during the making of the short film *The Voice from the Screen* produced by Bell Laboratories to demonstrate the new technology. The soundproof camera booth was left open to show the camera's operation, and three suspended microphones recorded the process of recording as well as the performance of musicians. Drapes reduced the reverberation, and the megaphone at the feet of Bell Labs vice president Edward B. Craft could have been used only to command silence on the set. Photo #W4991. Property of AT&T Archives. Reprinted with permission of AT&T.

Vern Knudsen—fortuitously located at UCLA—recalled being called in to the executive offices of Metro-Goldwyn-Mayer in 1928 to consult upon the design of their first soundstages. "We want these two stages, stages A and B," Louis B. Mayer explained, "to be insulated from each other so well that you can have gunfire on one stage and record chamber music on the other stage." "Well," Knudsen replied, "This calls for a very costly type of building." "We don't care," Mayer responded. "We want that; that's the requirement. That *must* be the requirement."[130]

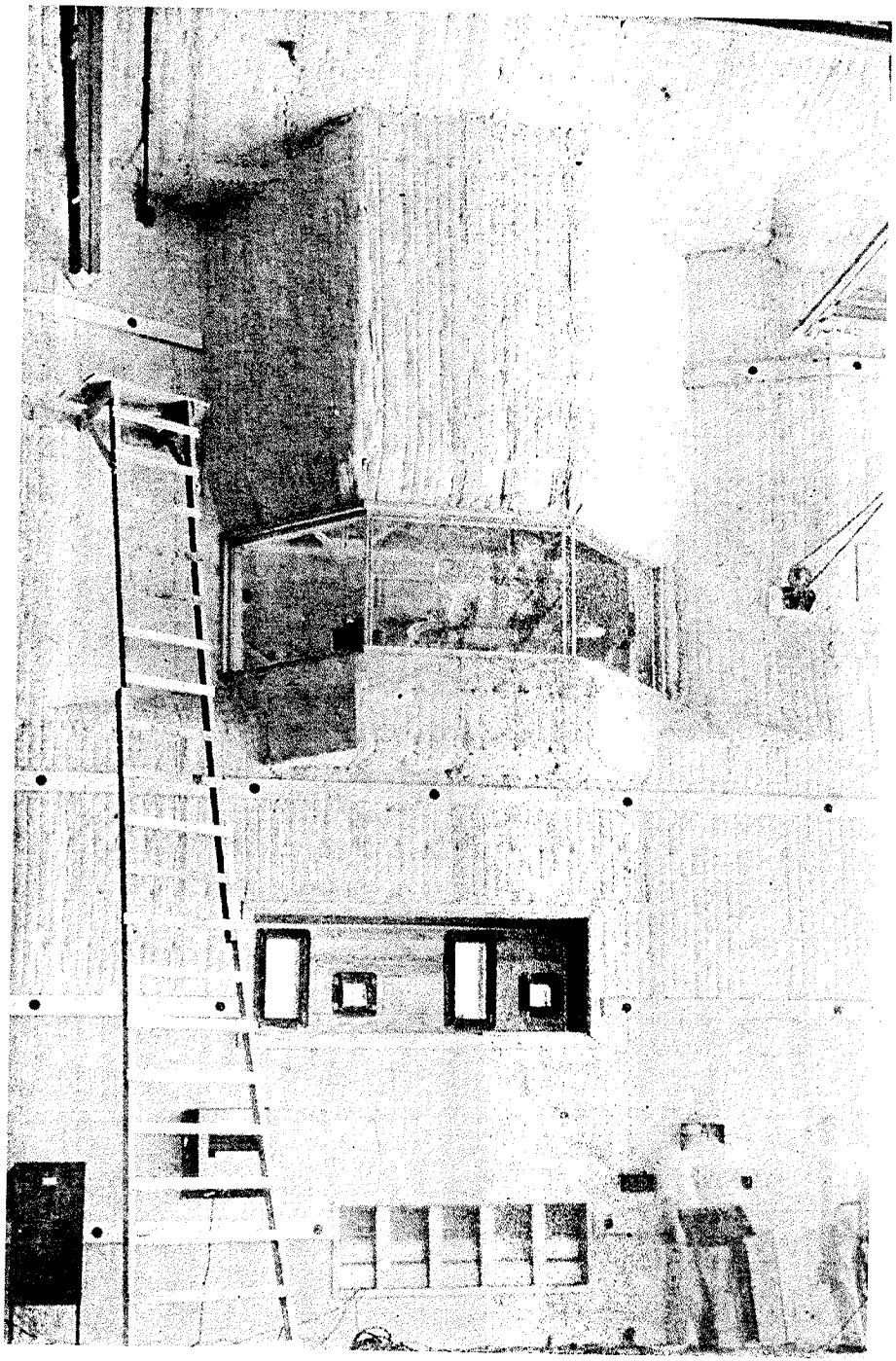
Knudsen supervised the construction of MGM's first two soundstages. They were heavy, rigid structures with ten-inch-thick concrete walls and a concrete slab ceiling to keep out external noise. The studios themselves were located within, but structurally isolated from, this outer shell, and were lined with thick layers of sound-absorbing material. The expense of this design led the studios to search for a cheaper method of construction that would provide the same degree of acoustical control. The use of multiple layers of building materials such as plaster- and fiber-board, separated by air spaces lined with sound-absorbing materials and mechanically isolated from each other, proved equally effective, and this type of building became the industry standard.[131]

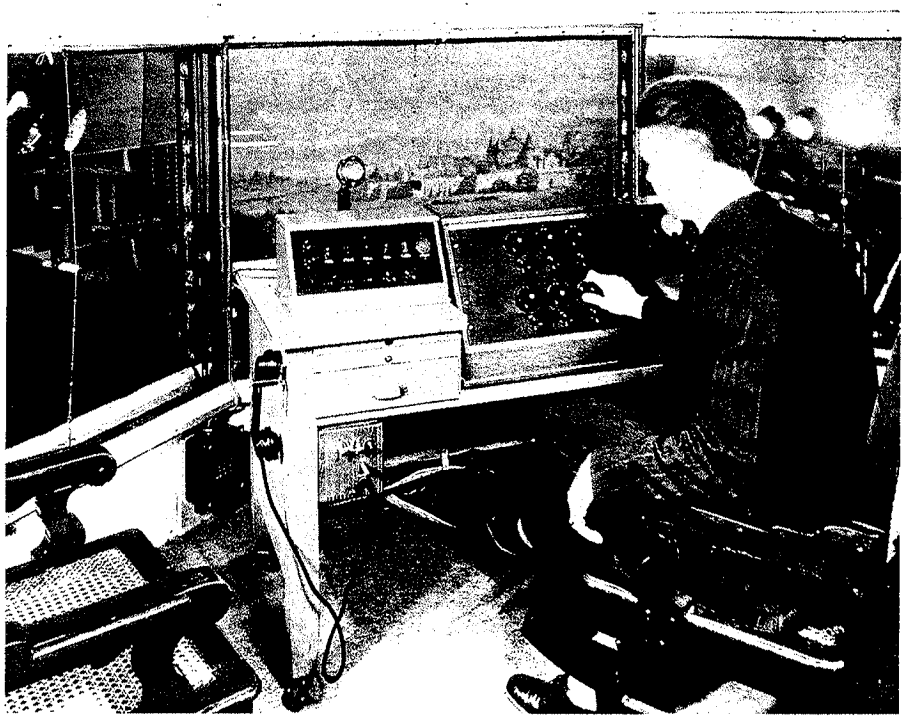
There was no debate about optimum reverberation for a soundstage; the goal was to eliminate it entirely. Even Joseph Maxfield agreed that the motion picture studio should be "as dead as possible."[132] While the complete elimination of reverberation was physically impossible, times well below 0.50 seconds were recommended and obtained, even in very large studios.[133] Such low reverberation times were effected by lining the entire stage with a thick blanket—as much as four inches—of sound-absorbing materials.[134] (See figure 6.16.)

Far above the silenced soundstage loomed the monitor booth, a glass-enclosed bay that housed the recording engineer at his mixing panel. (See figure 6.17.) Here, he adjusted and controlled the signals created by the microphones to ensure a high-quality recording. While little physical space was required to perform this task, the room in which he worked required a great deal of acoustical space. In order to create a recording that would sound good in a typical theater, the monitor room had to constitute an acoustical facsimile of such a theater. The room therefore had to be large, treated with acoustical materials to effect a typical theater reverberation time, and outfitted with loudspeakers identical to those used in theaters.[135]

Like the theater, the studio constituted a site where the distinction between architectural acoustics and electroacoustics was blurred, a place where sounds

6.16
Metro-Goldwyn-Mayer sound stage, c. 1929. The extensive acoustical treatment evident here would have rendered this large room almost completely nonreverberant. The bay window allowed the sound engineers in the monitoring booth to observe the action on the set below. *Western Electric News* 18 (April 1929): 36. Property of AT&T Archives. Reprinted with permission of AT&T.

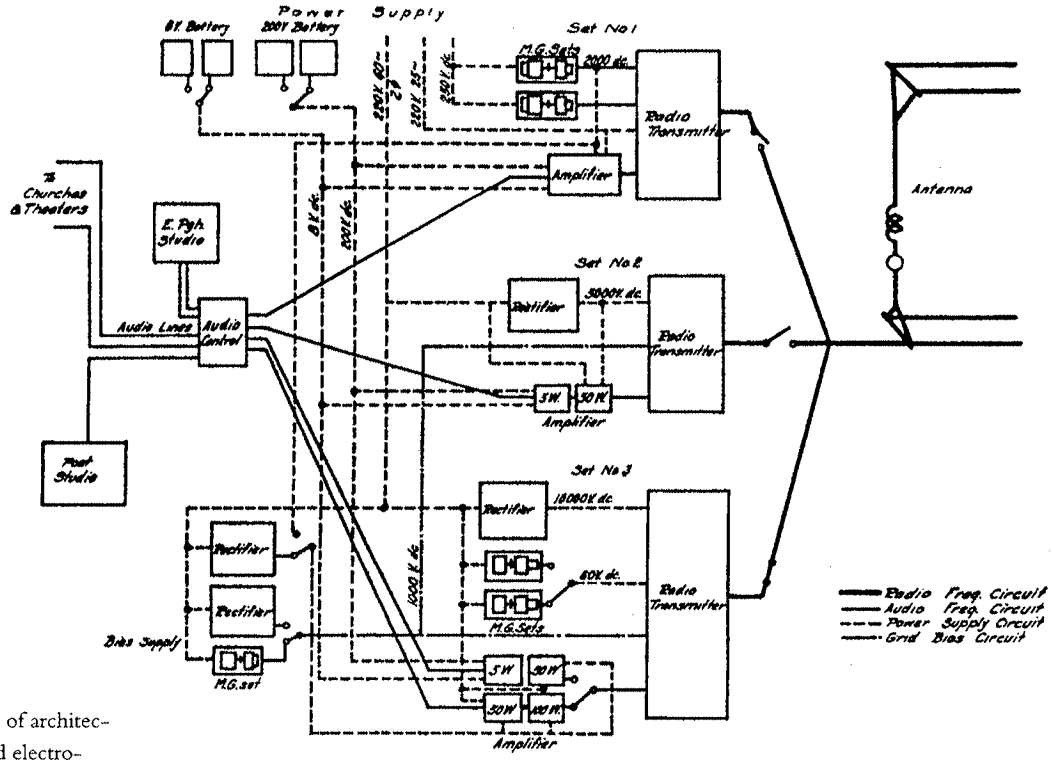




6.17
Sound engineer working in the monitoring balcony of an unidentified studio, c. 1929. The engineer balanced the signals from different microphones on the set by manipulating the dials on the mixing console. Telephones allowed him to communicate with people on the set below. Photo #W2085A. Property of AT&T Archives. Reprinted with permission of AT&T.

and signals combined and converged. As early as 1924, radio engineers had depicted the architectural space of the studio as a discrete element, like a rectifier or an amplifier, in their circuit schematics.[136] (See figure 6.18.) Multipaned monitor booth windows were compared to electrical filters, blocking the transmission of sound in the same way that those filters blocked the transmission of signals.[137] ERPI engineer H. C. Humphrey even suggested that a special monitoring headset could be designed to re-create, electrically, the acoustical characteristics of the average theater. A simple circuit could then replace the physical space of the monitoring room.[138]

There is no evidence that Humphrey's suggestion was carried out at this time. Still, studio technicians did manipulate electrical technology in other ways to create the effect of architectural space. When Edward Kellogg reevaluated the role of reverberation in motion picture theaters in 1930, his argument for eliminating it was based on the fact that "the desirable effects of reverberation can all be simulated by a high grade electrical system."[139] When Joseph Maxfield



6.18
The convergence of architectural acoustics and electroacoustics is documented in this circuit diagram for the KDKA radio station in Pittsburgh, which represents studio architecture as just another element of the circuitry. See boxes labeled "Post Studio" and "E. Pgh. Studio" toward the left of the diagram. D.G. Little, "KDKA: The Radio Telephone Broadcasting Station of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pennsylvania," *Proceedings of the Institute of Radio Engineers* 12 (June 1924): 256. © 1924 IRE, now IEEE.

declared that the soundstage should be as absorbent as possible, he, too, knew that there were other means—electrical means—to create the sound of space.[140]

V Electroacoustic Architecture: Sound Engineers and the Electrical Construction of Space

As acousticians worked to silence the architectural spaces of studios and theaters, sound engineers used their electroacoustic tools to fill that silence with a new kind of sound, the sound of the motion picture sound track. Just what a sound track should sound like, however, was not immediately evident, and the early years of sound film production were filled with debate over how best to answer this question. As MGM sound engineer Wesley Miller frankly admitted, the industry was "groping for an understanding of what is to be expected from the sound product itself."[141] The Society of Motion Picture Engineers, the American Society of Cinematographers, the Academy of Motion Picture Arts

and Sciences, and the Acoustical Society of America all served as clearinghouses for ideas and sponsored educational forums to keep everyone abreast of the rapidly changing state of the industry.[142] Between 1926 and 1930, as the nature of sound film and the techniques for creating it rapidly evolved, so, too, did ideas about how best to constitute the sound product.[143]

From 1926 through early 1928, sound movies consisted primarily of filmed renditions of staged musical performances (most notably, the Vitaphone shorts of vaudeville and opera stars), or sync-scored features like *Don Juan*, silent films accompanied by a recorded orchestral score and sound effects. In either case, it was assumed that the goal of recording was simply to re-create the sound of live theater, an aural context appropriate for both the filmed theatrical performers in the shorts and the recorded theater orchestra in the features. Paul Sabine, speaking before the Society of Motion Picture Engineers in 1928, argued that the engineers should strive to achieve "acoustic conditions for recording which will produce a record that most nearly simulates music and speech as heard by an audience from an actual stage."[144] He confidently asserted the ability of acousticians like himself to create those conditions through the techniques of architectural acoustics. But even at this early date, an alternative goal for the sound track as well as alternative means for achieving it were being developed.

In 1928, musical shorts and sync-scored features were suddenly overwhelmed by a new demand for "talking films," as Al Jolson's performance in *The Jazz Singer* captivated audiences and left them eager to hear more. While the film is famous for the brief dialogue that occurs between Jolson's character and his mother, its historical significance also derives from the fact that it moved the sound movie out of the "virtual theater" inhabited by the performers in Vitaphone shorts and by the orchestra members who created the synchronized scores of earlier Vitaphone features. The voice of Jolson's character was indeed heard in a theater, but also in a temple, a restaurant, and his mother's front parlor. With *The Jazz Singer*, the sound track began to move through space, inhabiting the numerous and diverse places that had long been represented visually in silent films.

Warner Brothers' first "all talking" film, *The Lights of New York* (1928), moved its audience around even more, from a small town to the lights and lures of the big city, including Broadway, Central Park, a barber shop, an apartment, and a nightclub "where anything can happen and usually does."[145] Once talking films began to present this variety of acoustical spaces, the goal of simply creating an accurate reproduction of "theater sound" was no longer perceived to be adequate or appropriate. As one engineer now suggested, "The reproduction

should sound the way you would expect the original to sound under the circumstances that are brought to your mind by the illusion created by the picture."[146] That is, a scene set in a large dance hall should sound different from a scene set in a small cottage, or one depicting people outdoors. Others, however, opposed this definition of the sound track, arguing instead that it was more important to maintain continuity of sound quality. According to this view, clarity and uniformity of sound were more important than spatial realism; if a person's voice sounded different in each scene, this would detract from, rather than enhance, the effect of the film.[147]

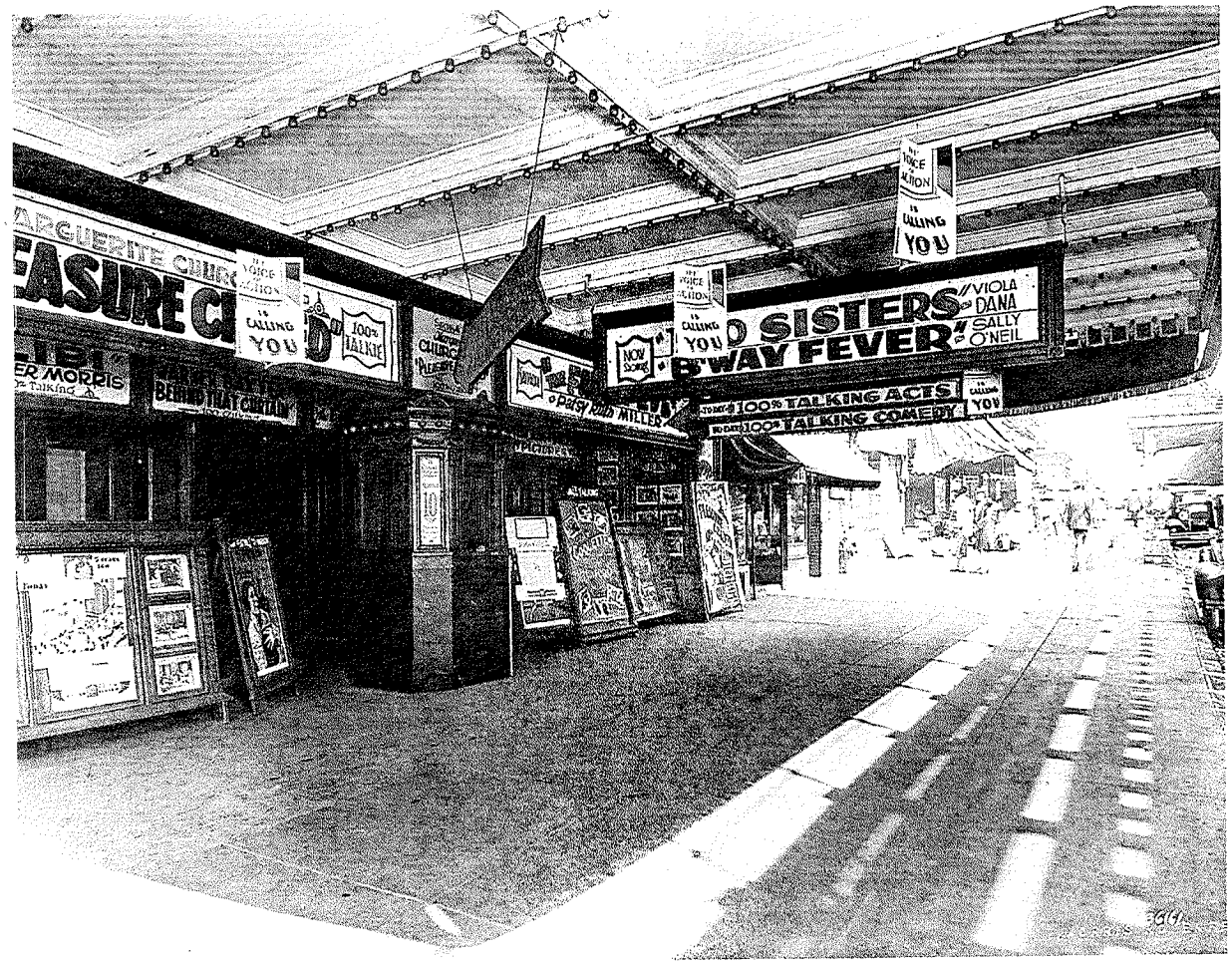
A theoretical debate about the fundamental role of the sound track was beginning to take shape, but in practice, sound engineers were initially preoccupied with the far more basic task of getting the new equipment to register the voices of the players on the set. Actors were required to stand still and speak directly into immobile microphones that were hidden in props or suspended above the players' heads just out of camera range. Carbon arc and mercury vapor lamps emitted audible and radio-frequency noises that were picked up by the recording equipment, so they had to be replaced with silent incandescent lamps. These new "inkies" were hot enough to melt makeup and to drench performers in perspiration, so the new soundstages now required powerful air-conditioning systems, which, if not properly designed, would themselves introduce mechanical noise. The camera, too, generated noise that was picked up by the microphones, so the camera and cameraman were encased within a small, soundproof booth equipped with a glass window out of which to shoot the image. Techniques for editing sound, on disc or film, were initially impractical, so scenes were shot and recorded in their entirety. If different camera angles of a given scene were required, multiple camera booths had to be set up to film simultaneously, so that each viewpoint would be synchronized to the recording. Cinematographers were thus forced to abandon their more creative lighting techniques, and instead provide flat, uniform lighting that generally served all camera angles at once.

The Lights of New York demonstrates well the many limitations imposed by the equipment and techniques of sound recording circa 1928; the film is infamous for its static camera work, flat lighting, and stolid pace. But it wasn't long before filmmakers and sound engineers found ways to transcend these limitations. Camera booths were placed on rubber wheels so they could be rolled around, and then were completely eliminated when quieter cameras, fitted with "blimps" or close-fitting sound-absorbing blankets, were introduced. By 1929,

6.19
Marquee at the Chaloner Theater, New York, advertising the Western Electric Sound System as "The Voice of Action," 1930. Current and coming attractions, all "100% Talking," include Chester Morris in *Alibi* and Mary Pickford in *Coquette,* her first talking film. Note advertisements for the sound system in the display cases at the left of the image and immediately to the right of the ticket booth. Note also the shadow cast by the tracks of the elevated train. Photo #W1953A. Property of AT&T Archives. Reprinted with permission of AT&T.

motion pictures were moving once again, and Western Electric began to advertise its sound system with a new slogan, "The Voice of Action." (See figure 6.19.)

Microphones also proved more mobile than had originally been assumed. The microphone boom appeared simultaneously in several studios, and by 1930 this portable, counterweighted support was standard equipment, allowing an operator to suspend a microphone immediately above the players and to follow them as they moved around the set. But even as the restored mobility of the camera and the newfound mobility of the microphone opened up new visual possibilities for sound films, the basic question remained of just what these films should sound like. The debate over "sound perspective,"[148] the relationship



between an image and its accompanying sound, grew louder as sound engineers gained control over their tools.

One fundamental question concerned how the volume level of the recorded sound should relate to the image on screen when a film cut between long shots, medium shots, and close-ups. If, for example, a woman were shown speaking to a man in a medium shot, and the film then cut to a close-up of her, still talking, should her voice suddenly get louder to match the increased size of her image on screen?[149] If a talking man were filmed gradually walking away from the camera, or if the camera pulled away as he spoke, should his voice level diminish as he receded into the distance? In each of these examples, the point-of-view presented to the audience moved through space; abruptly in the former, gradually in the latter. Whether the point-of-audition should similarly move was a question that had to be answered. The question of whether or not to represent aurally the particular kind of space depicted on screen was also reexamined, as sound engineers considered new means by which to control the amount of reverberation recorded on the sound track.

In 1928, Paul Sabine had confidently volunteered the services of architectural acousticians to control the quality of sound in the new sound films. The traditional, architectural means of control that Sabine proposed were indeed pursued by the motion picture industry, albeit in a slightly modified form. The "architecture" of motion pictures, like everything else associated with the medium, existed more as illusion than reality. Set designers used forced perspective and other tricks to create the visual effect of architectural construction out of flats made of paper, plaster, and two-by-fours. To control the sound quality of this illusory architecture, therefore, one had to control the acoustic properties of the sets out of which these virtual structures were made. Absorption coefficients previously determined by architectural acousticians were applied to the construction of stage sets, but it soon became clear that much of the acoustical data compiled by Wallace Sabine, Floyd Watson, and others was "useless for studio application."[150]

The problem was that these acousticians had measured the coefficients of materials employed in solid and substantial architectural constructions. What the studios required was data relating to how these materials functioned in the far less substantial construction of Hollywood stage sets. To determine these new coefficients, a special committee of the Academy of Motion Picture Arts and Sciences enlisted the services of Vern Knudsen and ERPI engineer F. L. Hopper. Working in Knudsen's new acoustical laboratory at UCLA, the men measured

the acoustical performance of different kinds of materials as employed in actual set constructions that were donated by the various studios.[151]

This material approach to the control of sound on the soundstage was, however, soon overshadowed by a new and more powerful means of control. As early as 1928, sound engineers had begun to use the tools and techniques of sound recording itself to create the effect of space. Indeed, even as Paul Sabine was promoting the value of architectural acoustics to the Society of Motion Picture Engineers, motion picture engineer Edward Kellogg steered the discussion away from the material control of sound, citing instead the power of electroacoustic tools to effect this control. "The liveliness of the room can be compensated for," Kellogg proclaimed, "by the position of the microphone." As Joseph Maxfield explained, "If you record only the direct sound, you can get a sound track without reverberation, but with the microphone farther away you get a record with considerable reverberation." One sound engineer suggested even further that multiple microphones could be used simultaneously in a dead room, as "a substitute for the reflecting surfaces."[152]

Others, however, opposed this technique. RCA engineer John Cass objected that, "When a number of microphones are used, the resultant blend of sound may not be said to represent any given point of audition, but is the sound which would be heard by a man with five or six very long ears, said ears extending in various directions."[153] Cass's description brings to mind the technique of cubist painters like Pablo Picasso, in which multiple visual perspectives were simultaneously represented on a single canvas. While Cass clearly opposed the construction of a cubist sound track, something very much like this—a sound track simultaneously everywhere and nowhere—would eventually become the industry standard. Clearly, as Cass, Maxfield, and Kellogg all recognized, the technique of microphone placement constituted a powerful new means by which to create or efface the aural effect of space. The opportunities afforded by the use of multiple microphones were increased even further as techniques for sound mixing, editing, and dubbing, or rerecording, developed.

The role of the "mixer man" in the earliest years of sound film was simply to monitor and control the level of sound being picked up by the microphone. If a voice was too faint or too loud, a turn of the dial on the mixing console would amplify or diminish the strength of the signal to an appropriate level before it was recorded. On sets equipped with several microphones, the mixer additionally had to follow the action, opening up, or activating, the microphone closest to the speaking actors, then closing it off and opening another when the

action moved to a different spot on the set. Background music also had to be added to the mix as the recording occurred. Often, a band or orchestra was written into the story so that it could appear on camera; otherwise, the musicians were located off stage and out of camera range. In either case, the mixer mixed the signals from the orchestra microphones with the dialogue signals of the actors as all performed at once. As long as scenes were shot and recorded in continuity, all of this manipulation and fine-tuning of the signal had to occur in real time, as the scene was played out before the cameras and microphones. As early as 1927, however, experiments in sound editing and rerecording had begun, and within a year or two these techniques were highly developed.[154]

It was relatively easy to cut and splice together different "takes" or recordings of sound on film; the challenge was to maintain synchronism with the separate strip of film that carried the image. Around 1930, special-purpose sound-editing consoles appeared to help editors meet this challenge. Soon thereafter, new kinds of film stock with sequentially numbered frames further expedited the process.[155] In addition to piecing together serially several recordings, the signals of multiple sound tracks could also be mixed together to create a new, combination track, as when a dialogue track was mixed with a track of synchronized sound effects or music. Here, the limitation was that, with each new generation, the level of noise inherent to the sound-on-film process increased. Finer-grained film stock helped alleviate this problem, until, in 1931, the aptly named ERPI engineer H. C. Silent designed a new "noiseless" system for sound-on-film recording.[156]

Although sound on disc could not be physically cut and pasted like sound on film, an extraordinarily complicated procedure was developed at Warner Brothers in 1928 to enable engineers to mix and edit disc-recorded sound.[157] But here, too, the noise level increased with each successive generation of reproduction. By the time Western Electric introduced their noiseless sound-on-film recording system, however, every studio in Hollywood—even Warner Brothers—had abandoned discs. Indeed, the increasing importance of editing played a strong role in the adoption of sound on film as the production standard for the industry.

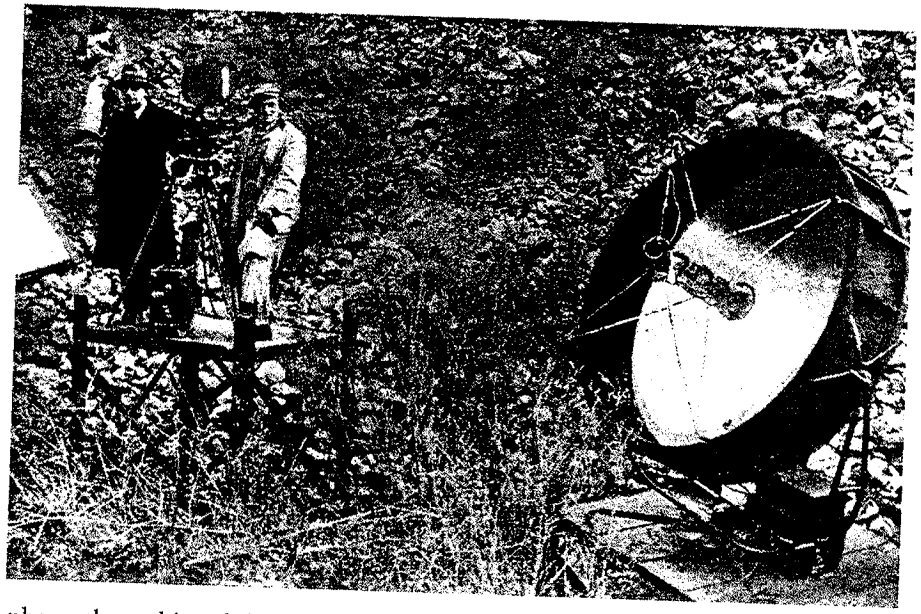
Sound engineers developed techniques not only to add and layer dialogue, music, and sound effects, but also to manipulate the quality of these constituent sounds. They eliminated certain kinds of noise with electrical filters, created sound fades and dissolves to segue one scene into another, and controlled widely ranging volume levels with automatic limiting devices.[158] Dubbing was now

dubbed of "supreme importance to the advancement of the art." "It makes possible," sound engineer Joe Coffman declared in 1930, "the improvement of voices and effects through changing their frequency content by use of the requisite filters; it permits almost any imaginable acoustic trick, and the inclusion of effects which occur as afterthoughts." "It is probable," Coffman predicted, "that within a year no original sound records will be used for the making of release prints of feature productions of high quality."[159] Indeed, as historian Donald Crafton has documented, by 1930 the sound track "came to be seen more as an ensemble constructed in postproduction rather than as a record of an acoustical performance."[160]

With this redefinition of the sound track, the task of studio recording was similarly redefined. Although some still argued for a recording technique that produced a "natural" representation of space that would necessarily vary from shot to shot, this approach was now seldom followed in practice. Instead, sound engineers focused almost exclusively on collecting a uniformly "close-up" sound signal. The goal was to capture the actors' voices clearly and directly, and this was accomplished by following the players closely with moving microphones suspended from booms. "When speech is picked up electrically with a microphone," RKO sound engineer Carl Dreher explained, "it is usually possible to secure high quality only by placing the pickup device relatively close to the source of sound." The best procedure, according to Dreher, was thus "to shoot close-up sound only, modifying the quality in re-recording when necessary to simulate more distant pickup for the long shot picture."[161]

When this technique proved impractical, for example, with extreme long shots in which a close microphone would fall within the camera's field of vision, new devices were devised to overcome the obstacles. "Sound concentrators" were developed at RKO in 1930 to enable engineers to obtain close-up sound from a distant source. These large, parabolic reflecting horns collected sound energy from the direction in which they were pointed, and focused that energy on a microphone mounted within the horn, effectively creating a highly directional and sensitive microphone. (See figure 6.20.) Concentrators allowed engineers to record physically distant sound with the desired close-up quality. Additionally, the directional characteristics of the concentrator contributed markedly to "overcoming the detrimental effects of reverberation or generally reflected sounds."[162]

Sound concentrators were used on a number of RKO films, including *Danger Lights* and *Cimarron*.[163] In 1931, RCA introduced a new type of micro-



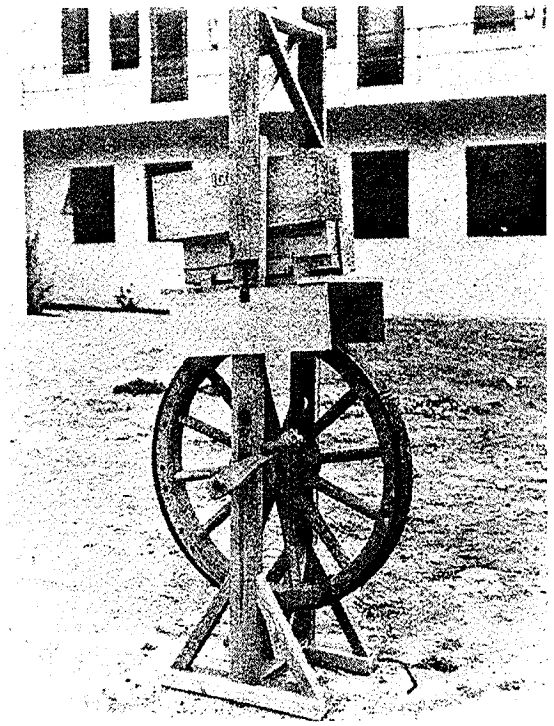
6.20
Radio-Keith-Orpheum film crew shooting a scene with microphone concentrators. The parabolic reflectors directed sound to a microphone mounted at the focus of the curve. These devices picked up sounds from a much greater distance than was otherwise possible, and they also allowed highly directional recording. Carl Dreher, "Microphone Concentrators in Picture Production," *Journal of the Society of Motion Picture Engineers* 16 (January 1931): 27. Courtesy Society of Motion Picture and Television Engineers, and Princeton University Library.

phone that achieved the same effect in a much smaller package, and RKO engineers were soon using these new "ribbon microphones" on all of their sound pictures.[164] Unlike omnidirectional carbon and condenser microphones, which picked up sound equally in all directions, ribbon microphones possessed strongly directional characteristics. They "listened" acutely to sounds directly in front, and "ignored" sounds coming from other directions. As a result, ribbon microphones picked up actors' voices loudly and clearly, even from a distance. They also reduced the pickup of studio reverberation to approximately one third the level recorded by omnidirectional microphones.[165] Microphone booms were equipped with swivel controls that allowed engineers to pivot and point the ribbon microphone at actors as they spoke, and the goal of recording clear, direct, close-up, and nonreverberant sound was fully achieved.

As Carl Dreher had noted, the close-up recording that resulted from the use of these tools constituted only the first stage in the construction of the sound track. The sounds on this recording were modified and mixed with others before they were released to the public. Each stage of this process, and each element in the mix, was now fully under the control of sound engineers. Perhaps ironically, those engineers sometimes chose to reintroduce certain kinds of noise into their painstakingly wrought noise-free recordings. Numerous early sound films took place in and celebrated the urban environment, and they often included aural montages of city noises in which car horns, police whistles, trolley bells, sub-

ways, and shouting newsboys were all heard.[166] Sounds that city-dwellers were seeking to escape in real life were vicariously enjoyed when experienced within the artificial—and highly controlled—setting of a sound motion picture theater, and the noises themselves were artificially created and controlled by sound engineers in the studio. For example, a special "noise machine" was constructed at one studio to simulate the noise made by a subway train pulling out of a station.[167] (See figure 6.21.) Not just the noise of machines, but the sound of space, too, was created in equally artificial ways.

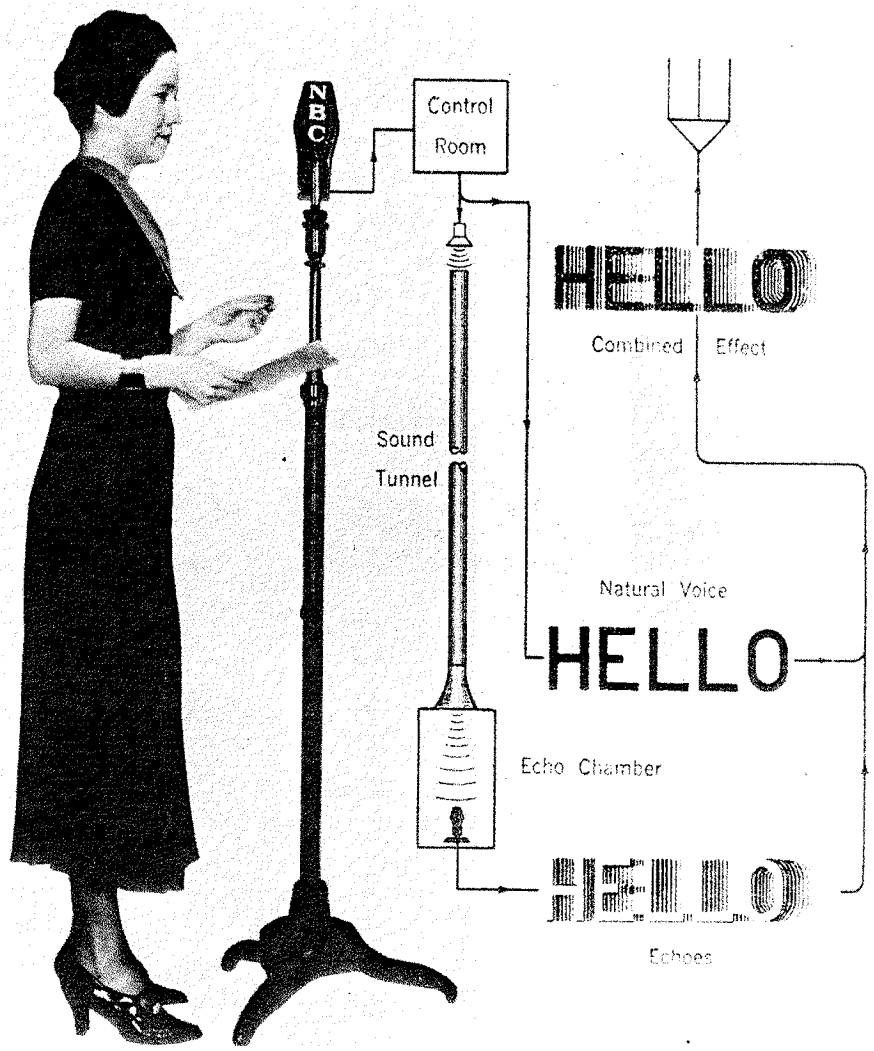
In 1930, Edward Kellogg described to the Society of Motion Picture Engineers how a British radio station had begun to add reverberatory effects to its program material through the use of a special "reverberant chamber," and American sound engineers were similarly experimenting with this new technique. In the broadcast studio, close-miking of the performers generated a non-reverberant signal that was subsequently directed to a distant loudspeaker that reproduced the sound in a small but hard-surfaced chamber. A microphone within this chamber picked up this sound, which now consisted of a highly reverberant reproduction of the original. The engineers then mixed this signal



6.21
"Noise Machine" at an unidentified Hollywood studio, 1929. Sound engineer Kenneth Morgan noted that devices for adding sound effects through rerecording were "both novel and elaborate as well as numerous." This device simulated the noise of a subway train pulling out of a station. K. F. Morgan, "Scoring, Synchronizing, and Re-recording Sound Pictures," *Transactions of the Society of Motion Picture Engineers* 13 (1929): 283. Courtesy Society of Motion Picture and Television Engineers, and Princeton University Library.

back into the original, varying the proportion of the two until just the desired degree of "space" was achieved, and this became the broadcast signal that listeners heard at home.[168] (See figure 6.22.)

While acoustical building materials had first introduced the possibility of transforming traditional relationships between sound and space, the new electroacoustic techniques associated with radio and sound motion picture production expanded these possibilities dramatically. As Edward Kellogg put it, "the



6.22
The NBC "Echo System." By the early 1930s, sound engineers for both radio and motion pictures depended upon systems like this to create artificially the sound of space by simulating echoes and reverberatory effects. "How Echoes Are Produced," *Broadcast News* 13 (December 1934): 26. Courtesy David Sarnoff Library, Princeton, New Jersey.

desirable effects of reverberation" could now be "simulated by a high grade electrical system," and these effects were now "subject to complete control."[169] The sound of space could now exist free of any architectural location in which a sound might be created; it was nothing but an effect, a quality that could be meted out at will and added in any quantity to any electrical signal.

By 1931, NBC had begun to add this "artificial reverberation" to radio broadcasts of the Roxy Theatre orchestra in order to "give to the listener a tone picture, corresponding to their impression of how the orchestra would sound to them were they present in the theater."[170] Filmmakers, too, began to explore the possibilities of simulated reverberatory effects. In John Ford's first sound film, *The Black Watch*, several scenes that occur within a "Cave of Echoes" have a distinctly reverberant quality that may have been achieved artificially. Two years later, in Frank Capra's *Platinum Blonde*, the character of Stew Smith, a hard-boiled journalist feeling increasingly trapped in his marriage to a wealthy socialite, shouts out his frustration in the cavernous foyer of their mansion. His voice echoes and reverberates, but when he subsequently turns and speaks to his butler, it is immediately close-sounding and nonreverberant, suggesting that the reverberant effect was achieved in postproduction.[171] Film historian Arthur Knight has noted that the strange mixture of sounds heard in Rouben Mamoulian's *Dr. Jekyll and Mr. Hyde* during the doctor's frightening transformation into the monster, includes "exaggerated heartbeats mingled with the reverberations of gongs played backwards, bells heard through echo chambers and completely artificial sounds created by photographing light frequencies directly onto the sound track."[172] By the mid–1930s, according to Rick Altman, devices for adding reverberation abounded.[173]

But if these new means for creating the sound of space were widely available, they were not widely employed. Nor, when used, was the goal to achieve an unobtrusively realistic representation of space, but rather to create discrete and highly irregular special effects. Sound engineers exercised their newfound ability to create the effect of space with remarkable discretion. The typical sound track of the early 1930s emphasized clarity and intelligibility, not spatial realism. Uniformity, not variation, was the norm, and a close-up, direct, and nonreverberant sound prevailed. Cuts between long shots and close-ups were seldom accompanied by volume level changes, and realistic representations of reverberatory spaces were presented even less frequently.[174] Donald Crafton has characterized the result as a "well-tempered sound track," and, as James Lastra has also established, the debate over how a sound track should sound was finally settled

"by the adoption of the standard of close-miking and a certain 'frontality.'"[175] Lastra characterizes the sound that resulted as "'contextless' or spaceless," bringing to mind the cubist sound track described by the sound engineer John Cass, who complained—to little avail—of the "indefinite position" of the auditor that resulted.[176] Having thus settled the fundamental question of what a sound track should sound like, these engineers left the historian another problem to ponder: Why didn't they take fuller advantage of their ability to add a spatial dimension to their sound tracks?

Many of these men were originally trained as radio and telephone engineers.[177] These industries had long emphasized clear, intelligible voice signals as the criterion for "good sound" and their engineers perceived reverberation as just another form of noise. When these men moved into the motion picture business, they brought those aural standards with them.[178] Radio and telephone engineers had also been trained to think of the sound they produced as a product, an aural commodity, and Rick Altman has argued that the kind of sound track they ultimately constructed privileged the listener as a consumer of sound, offering "sound that is made for us."[179] This sound was indeed attractive, not only to the engineers who produced it, but also to the listeners who consumed it, and to understand fully the source of its attraction, one need only consider the lives of those listeners within the larger soundscape that they inhabited.

The sound of the modern sound track only echoed that being heard in countless other contexts in modern America. From the soundproofed offices of the PSFS Building to the pronounced directional flow of sound at the Eastman Theatre and the Hollywood Bowl, to the electroacoustic offerings of Radio City Music Hall, this kind of sound was everywhere. In its commodified nature, in its direct and nonreverberant quality, in its emphasis on the signal and its freedom from noise, and in its ability to transcend traditional constraints of time and space, the sound of the sound track was just another constituent of the modern soundscape. Indeed, the sound track epitomized the sound of modern America. The many changes in the soundscape that had occurred since the turn of the century—the development of new tools for studying sound, the crescendo of new kinds of noise and the deployment of sound-absorbing materials, the rise of radio, and the transformation of the concert hall—all these phenomena culminated just as sound cinema was finding its voice. The voice it found thus proclaimed these changes loudly and clearly.

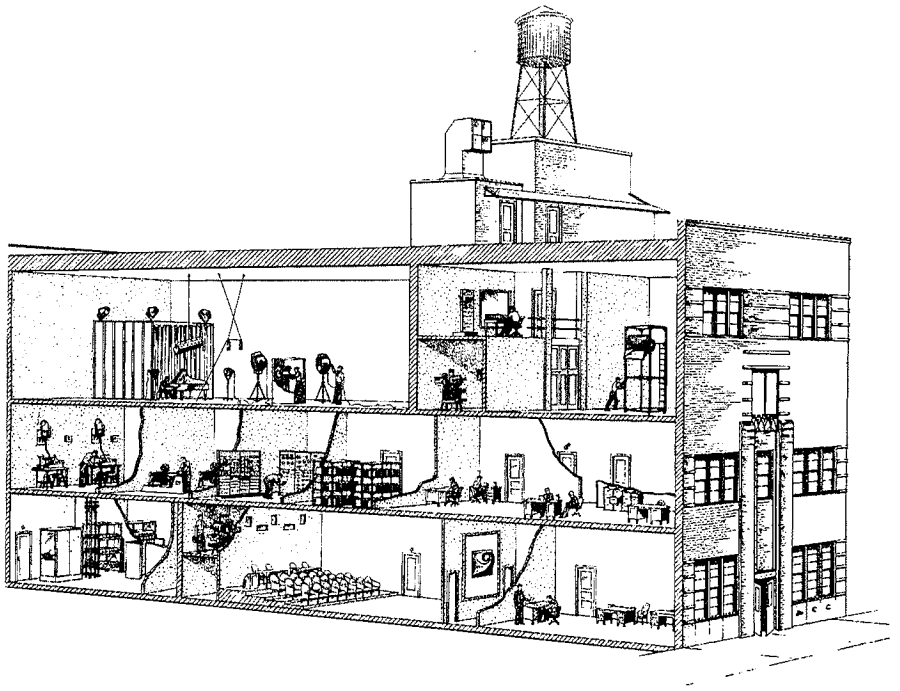
When Edward Kellogg reevaluated reverberation for the Society of Motion Picture Engineers in 1930, he noted that, in spite of the tremendous changes

wrought in the world of sound over the past thirty years, "the general conclusions reached in the pioneer work of Prof. Wallace Sabine have not been materially altered."[180] Kellogg did not realize that the very revision of Sabine's pioneer work that he subsequently called for was already under way.

VI Conclusion: Reformulating Reverberation

In 1929, Bell Laboratories opened a new facility at 151 Bank Street in New York for making experimental sound pictures "under conditions similar to those in practice."[181] The three-story building contained a soundstage, a monitoring room, film and disc recording rooms, developing and printing rooms, a small theater, dressing rooms, a film storage vault, and laboratories for research in optics and acoustics. The "central thought in the planning of the laboratory" was "to provide for experimental control of every factor influencing sound quality, from set and microphone to loud speaker and auditorium."[182] (See figure 6.23.)

The large monitoring room in the Sound Picture Lab was equipped with full-sized theater loudspeakers, and it was acoustically treated to simulate sound



6.23
Sound Motion Picture Laboratory, Bell Telephone Laboratories, New York, 1929. Designed "to provide facilities for making experimental sound pictures under conditions similar to those in practice," the laboratory allowed researchers at Bell Labs to experiment on the processes of making sound films. Photo #W2003B. Property of AT&T Archives. Reprinted with permission of AT&T.