SOUND ADVICE:
The Development and Use of Early 20th Century Acoustical Wall & Ceiling Materials

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Abstract

Acoustical materials are found in many early twentieth century public and other buildings where sound quality was important. Why were these materials developed and by whom? How do we recognize these materials? The purpose of this thesis is to examine the development of early acoustical materials from approximately 1890 to 1940, with a particular focus on acoustical plaster. The specific details of the type and technology of these materials have not been widely addressed. This research draws upon mostly the limited literature on the history of architectural acoustics, trade catalogs, and architectural journals.

Acoustical materials were needed because the new types of spaces that were built in the nineteenth century had faulty acoustics. People complained that they could not hear the speaker or the music well in places like theaters, auditoriums, or churches due to reverberation. Thus, acoustical materials were introduced as a means to correct sound problems. The goal of this thesis is to have a greater understanding of the technology and impact of these materials on the built environment, in addition to creating another source on the history of acoustical materials.
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Introduction

Acoustical materials are found in many early twentieth century buildings where sound quality was important. Why were these materials developed, and by whom? How do we recognize these materials? The purpose of this thesis is to examine the development of early acoustical materials from approximately 1890 to 1940.

Acoustics of buildings were affected by their size and by the use of new fireproofing materials within these enclosed spaces. Often, people complained about the unwanted noise and annoying echoes, whether it was in an auditorium or at the work place. The larger size of auditoriums built during the nineteenth century affected acoustical quality in a negative way, creating unwanted reverberation, defined as the persistence of reflected sounds from surfaces in an enclosed space. Materials—like steel, concrete, and hard plasters—created harder, reflective surfaces, which increased reverberation in enclosures. Consequently, lessening the intensity of reflected sounds was not only limited to large theaters and auditoriums. The introduction of steel in furniture and appliances, and concrete floors in places like offices, banks, schools, and hospitals, too, created a distracting atmosphere within a room. When the noise of voices or machines constantly filled an enclosed space that consisted of highly reflective surfaces, numerous reflections would accumulate.

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and increase in sound intensity, resulting in an awful din that was bothersome to those using the space. Ultimately, reverberation became an acoustic problem that needed correcting.

To address these issues, architects and builders retrofit existing buildings, using known materials, such as cloth or canvas, to correct sound problems. However, the sound in a building and architectural acoustics were not completely understood. Architects knew that they needed to design their spaces so that even people sitting in the back could hear, they knew that unwanted noise created headaches and that large empty rooms would create an echo, but they did not know how to fully fix these problems before construction.

The technology of sound control was in its infancy. Very few specialists in the acoustic field existed, and even fewer architects with acoustical expertise could offer corrective advice. Architects wanted a set of guidelines in designing structures with successful acoustic properties. One man who pursued the science of acoustics was professor and physicist Wallace Sabine. His scientific studies gave a better understanding of how sound moved through a space. Sabine devised a formula, effectively creating a quantitative method for measuring the amount of sound reverberation within a room. Once the reverberation time was known, reverberation could be counteracted using materials to absorb the prolonged sound. It became possible to design acoustic performance before construction.

Sabine’s research formed the foundation of modern architectural acoustics; his work influenced the field as a whole, but his formula for reverberation was by no means an entire guide for how to fix poor acoustics. Another element was needed, acoustical materials, which could absorb

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sound within enclosed spaces. It is important to note that all materials absorb some sound, but an acoustical material is defined as a material that is specifically designed to absorb sound.⁵

This thesis will address the most common commercially manufactured materials designated for sound absorption, such as felts, fiberboards, tiles, and acoustical plasters. The first chapter will establish a brief history of architectural acoustics from the nineteenth century into the twentieth century. Subsequent chapters will trace the development of acoustical materials and discuss the technology of the materials, for instance, their properties, advantages, disadvantages, and their effectiveness as a sound absorber. Finally, the last chapter will cover present preservation issues, because issues with acoustical materials are today often inadequately addressed. The goal of this thesis is to have a greater understanding of the technology and impact of these materials on the built environment, in addition to creating another source on the history of the development of acoustical materials.

Chapter 1: Brief History of Architectural Acoustics Leading to Development of Sound-Absorbing Materials

What is sound? Sound is a wave motion in the air that is produced by any vibrating body. The sensation of sound is due to stimulation of the auditory nerve of the ear by sound waves produced by the vibrating body. A vibrating body imparts a portion of its energy to the surrounding air, compressing the layers of air adjacent to it, which causes an increase or decrease of pressure in the surrounding atmosphere. A normal ear is capable of detecting these alterations of pressure. The transfer of energy through the air by successive pressure variations is called a sound wave. Sound waves need a medium to travel through; they cannot travel through a vacuum. When a sound wave strikes a wall, or any material surface, some of its energy is absorbed and the rest of the energy is reflected and transmitted. Hard and flat surfaces tend to reflect more sound than soft or uneven surfaces.

Sound creates an aural environment, influencing what we hear and providing stimulus. There are two types of sound, productive and counterproductive, involved in the aural environment and all social process. A productive sound is produced deliberately and is the end product of the process. For instance, the sound that comes from speaking to a friend or playing an instrument are productive. A counterproductive sound—called noise—is produced incidentally and is a byproduct

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of the process. This occurs when we accelerate a car or use a hammer against a nail. However, “even productive sound is socially useful only as long as it is confined to the immediate environment for which it has been produced.”

In other words, if a sound is something we do not want to hear, then even a productive sound can become counterproductive, or bothersome, like the noise coming from a neighbor’s overly loud stereo or the reverberation in a room.

An impediment to good sound quality is reverberation, which is the continued reflection of sound after the original source has stopped. Excessive reverberation intermixes sounds, turning productive sound unintelligible. Our ability to understand what we were hearing or to concentrate on what we were doing is threatened. Reverberation impacts hearing conditions and creates confusion and noise. It interferes with people’s understanding of the words of the speaker or the notes of music being played. It also distracts people, making them lose focus or producing headaches, which results in loss of concentration.

The quality of sound has always been important. Many attempts have been made over time to provide good sound quality. The Greeks with their amphitheaters were as concerned with sound as we are today. It was not until the end of the nineteenth century with scientific inquiries into the nature of sound, that people began to understand the effect of building materials on sound. And with this, they needed to also understand the significance of acoustical materials to diminish counterproductive sound.

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An “acoustical material” is defined as a material specifically designed to absorb sound that is applied to the surface, forming the exposed finish of a wall or ceiling. Acoustical materials were needed in the late nineteenth century due to the change in building technology that resulted in larger spaces and the use of hard and/or fireproof materials, such as steel, concrete, stone, and hard plasters, which led to excessive reverberation. An important factor that controls reverberation is the absorbing power of the materials that compose the interior finish. The initial purpose of acoustical materials was to reduce reverberation in order to provide good acoustics within auditoriums, by increasing absorption. The secondary purpose of these materials was for sound quieting in public spaces, such as offices, restaurants, schools, and hospitals.

Sound quality was important, but fire safety was too. Fireproofing became an important factor in designing buildings that held large numbers of people. Following events like the Great Chicago Fire of 1871, which destroyed a large portion of the city’s central business district and killed up to 300 people, it was essential that buildings be made of fireproof materials to prevent the dispersion of fires and any consequential deaths. This fire spread easily because wood was the predominant material used on buildings, roads, and sidewalks, and because flammable tar or shingles topped these buildings. Other non-flammable materials were needed.

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The other factors are the design and shape of the room, but discussion of these aspects is beyond the scope of this thesis.

Materials used in the late nineteenth century for fireproofing included brick and concrete. They are non-combustible materials: Bricks consist of fired clay and sand, and concrete is a mixture of sand, gravel, crushed stone, or other coarse material, bound together with lime or cement. These are all materials that can withstand high temperatures. Buildings made of brick and/or concrete were structurally sound and solid, which made for effective fireproofing. While hard and/or fireproofing materials promoted safety standards, they created acoustical difficulties. Additionally, many auditoriums, cathedrals, offices, banks, restaurants, and other public or industrial buildings were being constructed with concrete or stone walls and floors, flat plaster walls, or plate glass windows.

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windows. The materials used in these types of buildings, especially those with high ceilings, had hard surfaces that reflected large amounts of sound, creating significant—and unwanted—reverberation.

Auditoriums, which host oral and musical performances, were commonly affected by reverberation. Some auditoriums were quite voluminous, so problems of echoes and delayed reflections, or a series of reflections, existed because sound had many surfaces upon which it could reflect, creating a distraction that audiences could hear for as long as the orator continued speaking or the music continued playing. The primary objective of the acoustical treatment in auditoriums was to diminish the reflective power of the walls and ceilings to the point where its negative effects were eliminated. This ensured satisfactory conditions for the hearing and understanding of speech by minimizing the distractions, as well as pleasing acoustical conditions for the listening of music. Otherwise, the space no longer functions for its intended purpose.

Some structures were built without good acoustics because architects of the time did not foresee this problem. In the design and construction of buildings, architectural forms and materials took precedent over acoustical quality because the nature of sound was not yet fully understood. In other words, architects did not choose forms or materials based on their acoustical qualities. Buildings created during the City Beautiful Movement are an example. The City Beautiful Movement

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was an American urban-planning movement that flourished during the 1890s and 1900s.\textsuperscript{24} There was a desire for grand buildings. Advocates of the City Beautiful were inspired by classical Roman architecture and believed beautification of architecture and public spaces would promote social order and increase quality of life.\textsuperscript{25} The focus of the architecture was on harmony and balance, which came at the expense of good acoustics. The forms of barrel vaults, domes, semi-circular rooms, and the finishing materials of marble, tile, or plaster “created spaces with intolerable reverberation.”\textsuperscript{26} The acoustics of rooms that utilized forms and materials like these were left to be corrected later.\textsuperscript{27} Throughout the nineteenth century, architects did not know for certain what the sound quality inside their buildings would be like until after construction.

In addition to the questionable quality of sound, there was a need to reduce noise levels in spaces where its numerous occupants might become annoyed or distracted by noise. One example of this is offices with new large, open layouts. This updated floor plan provided better light and ventilation, and facilitated the work of various departments through closer contact.\textsuperscript{28} There could be as many as fifty or sixty people working in one open room, but one small sound from the corner could reverberate through the whole space. With more people came a collection of noise: different


conversations happening simultaneously, the ringing of telephones, the shifting of papers or chairs, and the constant tapping of keys on typewriters or adding machines. Another example is large restaurants. Restaurants were dependent on a quiet atmosphere and good working conditions for reliability and accuracy. Noise in dining areas was bothersome to both patrons and employees. The ability of waiters or waitresses to hear and recall orders and requests of patrons correctly was crucial for these establishments. Incorrect orders and other issues lead to customer dissatisfaction, whether because customers felt they did not receive the service they deserved or they felt they could not enjoy their meal because of the loud and disagreeable atmosphere. In public rooms like these, the concrete floors and hard, smooth wall surfaces, with little or no relief ornamentation, created a condition that allowed for sound to reflect off a lot of surfaces, continuously amplifying it. These noises would fill the entire room and act as a serious deterrent to concentration and efficiency. The cumulative effect of these noises presented serious problems.

Acoustics of buildings could not be determined prior to construction; they were essentially determined by trial and error. But the uncertainty of sound quality in an enclosed space became an increasingly pressing issue. The need for sound-absorbing materials led to scientific investigations into architectural acoustics.


Architectural acoustics was a hard subject to approach because acoustics encompasses several disciplines. The factors to consider are the size and shape of the room, the purpose of the room, the type of architectural features, the nature of materials used, and the behavior of sound. All of these varying criteria meant that the information on architectural acoustics was inconsistent and difficult to follow. One of the main factors that led to this inconsistency was that the nature of sound was thought to be geometric rays instead of waves. Many scientists and researchers of this time thought that these “rays” of sound needed to be reflected properly to ensure good acoustics, and so, they focused solely on form. Through further observations, however, wavelike models and theories of sound as a field of energy gained hold and became the dominant ideas in the discussion of the nature of sound and how to control it. Scientists discovered that reverberant sound must be absorbed, not reflected. In 1853, medical doctor J. B. Upham discerned that reverberant sound “must be adequately suppressed” by putting in upholstered benches, installing carpets, and hanging curtains around the windows, which cut down reverberation to a bearable minimum. His

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34. Emily Ann Thompson, “‘Mysteries of the Acoustic’: Architectural Acoustics in America, 1800-1932” (Ph.D. Diss., Princeton University, 1992), 24. Benjamin Latrobe was the architect who brought over neoclassical architecture from England to the United States. In the early nineteenth century, based off his experience in improving the acoustics of the Hall of the House of Representatives in the Capitol Building at Washington, Latrobe characterized sound as geometric rays, which led him to believe that the solution to improve acoustics was to adjust the architectural form of the space. Architects designed these spaces according to Latrobe’s philosophy, but still without full comprehension of the nature of sound and what affected the acoustics.


36. Emily Ann Thompson, “‘Mysteries of the Acoustic’: Architectural Acoustics in America, 1800-1932” (Ph.D. Diss., Princeton University, 1992), 33. Architects of the nineteenth century, such as Benjamin Wyatt, George Saunders, and Pierre Patte, acknowledged the role of materials in affecting the sound of a room. That is, they knew materials were needed, but they did not know how to quantify these materials’ acoustical properties.


conclusion was that form was not the only factor to be considered in dealing with acoustical difficulties—materials, too, were a factor—and that architects and scientists needed to study this subject more in depth.39

These ideas were further tested before the turn of the century and into the twentieth century. American physicist Joseph Henry, who believed sound was a form of energy, was one of the first to qualitatively examine the sound-absorbing properties of materials.40 He affirmed that four conditions influenced reverberation: first, the size of the room; second, the strength or intensity of the sound; third, the position of the reflecting surfaces; and fourth, the properties of the material of the reflecting surfaces.41

The science of acoustics was not truly understood until Professor Wallace Sabine began his research in 1895. Sabine is considered the founder of modern architectural acoustics. He was the sole researcher of reverberation for several years and continued studying it until his death in 1919.42 Sabine first worked on the problem of reverberation when he was a young physics professor at Harvard University. The recently completed Fogg Art Museum at Harvard had a lecture hall that was considered unusable due to the poor acoustics. There was so much reverberation that it generated a prolonged echo, which made the speaker’s voice incomprehensible to listeners.43

Harvard President Charles Eliot then asked scientists within the faculty for acoustic correction

advice, and Professor Sabine rose to the occasion. Per Eliot’s suggestion, Sabine looked into a means to measure acoustical quality in a quantitative way. Sabine endeavored to measure the time of reverberation, or the amount of time it takes for sound to decrease to one-millionth of its initial intensity after the sound source has stopped. He measured the reverberation time, in seconds, in the Fogg lecture hall and other rooms on the Harvard campus. And for a while, Sabine could not figure out how to use his measurements to derive a “mathematical relationship between the architectural properties of a room and its reverberation time.” In 1897, two years after he started his investigation, Sabine still had not determined the relationship, but Eliot, desperate to use the Fogg lecture hall, urged him to prescribe a solution. Thus, Sabine decided that panels of sound-absorbing felt should be mounted onto the walls because he knew that as long as there were enough materials to absorb reverberant sound, the lecture hall would at least be usable.

Sabine continued his investigations even after giving such advice. In fact, soon after his prescription for the lecture hall, he figured out the mathematical formula he needed to compare the architectural properties of a room to its reverberation time. This formula could thus explain mathematically why reverberation seemed to occur more in rooms with large volumes. Small rooms easily contained enough sound-absorptive materials like rugs, curtains, and furniture to offset reverberant sound, whereas large, voluminous rooms did not. Basically, small rooms were known

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to have shorter reverberation times and large rooms had longer reverberation times. More importantly, the formula could now be used to determine the reverberatory quality of a room before construction.

Architectural acoustics was a complex problem with a number of conditions that had to be considered, but Sabine was able to clarify this complicated topic. He studied reverberation extensively, and discovered a way to measure the relationship between the size of an enclosed space and the amount of absorption surface present, in order to obtain quality acoustics, that architects could apply to their designs. Essentially, excessive reverberation and noise could be reduced by utilizing a sufficient amount of sound-absorbing materials. Following his publications between 1898 and 1900 on his research on reverberation, other researchers were better equipped to address acoustical issues. The sound quality within an enclosure received more attention, and people began to formally study architectural acoustics, now that the science of acoustics was better

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51. Wallace C. Sabine, *Collected Papers on Acoustics* (Cambridge: Harvard University Press, 1922); Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933* (Cambridge, MA: The MIT Press, 2004), 27. Joseph Henry, an American physicist and first Secretary of the Smithsonian Institution, made an early attempt to quantify the effect of materials upon sound. He sounded a tuning fork, placed the stem of the fork against the material to be tested, then measured how long the fork continued to vibrate. Henry believed his eyes were more sensitive than his ears, so he marked the cessation of vibration at the moment he could no longer visually perceive the movement of the fork. This measure of time represented the sound-absorbing property of the different materials he tested, including cork, rubber, wood, and stone. Joseph Henry’s experiments were an innovative attempt to analyze and to quantify the sound-absorbing properties of materials, but there is no indication that he applied his results to any structure. In his experiments on materials, he was ultimately more interested in the energetic properties of sound than with producing results that architects could use in their practice.
understood. Early researchers who studied this new branch of architectural acoustics were Clifford Swan and Vern Knudsen. They continued to build off Sabine’s work by researching the effect of the shape of a room on sound and the intelligibility of speech, and by measuring the reverberation time of different architectural materials.

Acoustical materials created an optimal condition for an environment that had a positive effect on those who used the space in which they were installed. In surroundings with good acoustics, no one had difficulty hearing or being heard. Dictation was clear and free from errors; formal conferences or informal conversations proceeded without participants failing to hear what was said; and the “entire nervous system of the person [was] relieved from the incessant bombardment of irritating noises.” Thus, those who were in a quiet environment were in a better mindset to understand what was going on, to be productive, or to be better adapted to solve problems. They were not as fatigued at the end of the day as those who were in the presence of noise. As these positive effects became known, architects and builders were finding a growing market for acoustical improvements in public and commercial buildings.

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52. Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933* (Cambridge, MA: The MIT Press, 2004), 87. The study of sound was a growing field in the first decade of the 20th century, but with the Great War, the focus of researchers, like Sabine, Dayton Miller, and Arthur Webster, shifted to sound problems related to the war, e.g. sound underwater or in airplanes.


Wallace Sabine’s *Collected Papers* are considered to be full and complete on the subject of reverberation. Other acoustic questions involved the transmission of sound through walls or the effect of resonance, etc.


Chapter 2: Acoustical Felts, Tiles, & Fiberboards

Early attempts to deal with acoustical problems in buildings used readily available materials that were almost always surface-applied or furniture that could be placed in rooms. Many of these materials, while they were easily used in residential spaces, were not always appropriate in significant public spaces. By the early twentieth century, architects, engineers, builders, and designers began addressing sound qualities in their buildings by modifying interior finishes. The most effective modification was the introduction of a variety of acoustical materials. They helped address the issues of reverberation, and as their technology progressed, acoustical materials covered a wider range of sound issues: Architects observed that these acoustical materials were also effective for noise quieting. By World War II, acoustical materials were utilized almost anywhere from public venues to private spaces.

When the science of acoustics was better established following Sabine’s discoveries, sound-absorbing materials became a focus of attention. There needed to be a sufficient amount of material in the room or on the walls to absorb excessive reverberation. Soft, porous, and compressible materials, such as curtains, draperies, carpets, and upholstered furniture were used to treat poor acoustic conditions.56 These furnishings were made from burlap, canvas, hair felt, and other textiles. They neutralized the effect of hard, sound-reflecting surfaces in the room.

Early sound-absorbing materials consisted of loose cloths or fabrics that covered the walls; draperies that hung at the windows; and carpeted floors.57 All of these materials were applied after construction. They were not considered to be “acoustical;” they were simply materials that were

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observed to absorb more sound than other known materials, even though their original purpose was not to do so.

An acoustical material is a material especially designed to function primarily as a sound absorber. One of the first materials used for its acoustical properties was acoustical felt. These particular felts became available in the early 1910s. Felts were softer, more flexible, and easily mounted. They were sold in rolls, could be cut into any width or shape, and nailed to the walls or ceilings. Acoustical felts were made of animal hair, flax fiber, mineral wool, wood fiber, or asbestos fiber. The fibers and felts were chemically treated with a fire retardant, and those that contained or were mixed with asbestos were advertised to be fireproof. The crisscrossing and layering of the felt fibers created small air chambers, or pores, which made acoustical felts an effective absorber. The degree of sound absorption is influenced by air flow resistance, which, in turn, is influenced by “the nature of the pore structure and the degree of intercommunication between pores.” Generally, these hair, wool, and fiber materials were packed between burlap or paper and covered with a suitable membrane as a decorative effect for the product. Acoustical felts were protected either by a cloth membrane or another kind of flexible membrane.

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Using existing technology, companies that were already producing felted roofing and building insulation materials started producing these felted acoustical materials. In the early days of the acoustical materials field, only a few companies existed. H. W. Johns-Manville Company was one of the first companies to appear in the acoustics category of trade catalogs and to manufacture a surface-applied acoustical felt. According to the H. W. Johns-Manville Company brochure, they were advertising their surface-applied acoustical felt in 1911.\(^6\) By the 1920s, other companies, such as Junius H. Stone, Mazer Acoustile, and Union Fibre Company, began to advertise their acoustical felt products.

\(6\) See Appendix A for a company advertisement. Photos of the felt product itself were not often displayed in company advertisements; only a description of the felt was given (along with photos and descriptions of other products sold by the company). Acoustical felts were generally not considered aesthetically pleasing.

The acoustical felts manufactured by H. W. Johns-Manville Company were covered with dyed muslin, a solid canvas, or “Nashkote” which was a perforated cloth, all of which preserved or even enhanced the absorptive value of the felt. The installation process of acoustical felts was a three part system. First, furring strips had to be fastened into place, then acoustical felts were mounted, and lastly, the membrane was applied. The membrane could resemble the surrounding finished surface and conform to architectural features (Figure 1). Johns-Manville’s Nashkote Felt.

Figure 2. According to the source below, Johns-Manville acoustical felt was installed in the ceiling at the Federal Reserve Bank, Transit Dept., New York City (ca. 1920).

66. The mesh of the cloth is coarse enough that the paint does not close over the individual meshes.


68. See Appendix A for recent color photo. Needs further investigation on whether the acoustical felt still exists behind the wall draperies.
could, for instance, have a textured surface that resembled a plaster or tile surface, suitable for banks, office buildings, and other professional places of work (Figure 2). 69 Johns-Manville Akoustikos Felt was layered to the requisite density—typically an inch thick—for the proper degree of sound absorption. 70

In addition, the membrane could be painted to resemble anything that can be done by painting on canvas. Some acoustical felts could be decorated with a flexible or porous paint—oil or lead—if covered with a coarse mesh cloth, such as a cider press cloth. And because the mesh of the cloth was coarse enough where the paint could not close over the individual mesh openings, the absorptive quality of the felt was retained. 71

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The advantage of acoustical felts was that they could be used in a variety of rooms, because of their flexible and sound-absorptive nature. Felt installation worked best when the felt was placed onto exposed surfaces and was not subject to compression. They could conform to architectural features, including curved surfaces. However, if compressed, the pores became ineffective as they could no longer communicate with each other and with the surface. The air space in between the felt and membrane—generally an inch wide—also contributed to the felt’s high efficiency in sound absorption because air is a medium that slows down and allows the sound waves to pass through, instead of reflecting them back like harder surfaces will.72 Acoustical felts had a highly absorbent surface, absorbing an average of 60 to 80 percent of incident sound energy.73 As the popularity of acoustical felts grew, they were installed in all kinds of buildings throughout the United States, including, but not limited to, schools, banks, hotels, restaurants, churches, hospitals, court rooms, office buildings, and music rooms (Figure 3).74 The choice for a

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74. See Appendix for recent color photo. Needs further investigation on whether the acoustical felt still exists behind the tapestries.
decorative membrane was particularly suitable for churches (Figure 4). The acoustical felts that were covered with a perforated surface could be cleaned, which meant they could be used in high-traffic areas, such as hospitals, hotels, restaurants, and other public halls. By 1930, acoustical felts could be found in many public or office buildings, where speech and music could be heard without strain, or where the noise level was reduced so that it was no longer bothersome.\textsuperscript{75}

Acoustical felts had quite a few drawbacks, too. They were susceptible to decay and they were not vermin-proof. Over time, moisture caused the felt to deteriorate. Since hair felt was usually made of cattle hair, it contained animal oil, dirt, and small pieces of hide if it was not prepared carefully or chemically treated.\textsuperscript{76} The felt became unsanitary, and at times, rodents would eat through it.\textsuperscript{77}

In addition, the surfaces of these materials soiled and gathered dust after a few years. Dust clogged the pores of the membrane, which in effect, decreased sound absorption. Also, dust made the surfaces duller, less efficient in light reflection, and it spoiled the decoration.\textsuperscript{78} The cleaning process was tedious as these acoustical felts covered many ceiling and wall surfaces in a room; and the membrane had to be carefully scrubbed to prevent scratches or rips, or risk the negative effect

\begin{itemize}
\item \textsuperscript{77} Floyd R. Watson, \textit{Acoustics of Buildings} 2\textsuperscript{nd} Ed. (New York: John Wiley & Sons, Inc., 1930), 60.
\item \textsuperscript{78} F. N. Vanderwalker, \textit{Drake’s Cyclopedia of Painting and Decorating: Methods, Tools, Materials, for Home and the Workshop} (Chicago: Frederick J. Drake & Co., 1945), 11-12.
\end{itemize}
on the aesthetics and the sound-absorbing qualities. By 1940, acoustical felts were seldom used due to the difficulty of maintenance.79

Another problem with acoustical felts was the finished surface of acoustical felts could not be painted because paint filled the pores in the cloth, blocking the passage of sound to the felt absorber underneath.80 Attempts were made to address this problem and special rubber-like paints were developed that left the pores of the membrane open for sound absorption.81 The effectiveness of this paint on acoustical felt needs further research.

Finally, acoustical felt-and-membrane systems were less convenient to install than some of the later acoustical materials, such as tile or fiberboard systems, which required less skilled labor for installation. It was a cumbersome and inefficient process to have to manage, especially when felts were not exactly permanent materials. Another aesthetic problem was that the seams around the acoustical felts were noticeable.

Although felts, curtains, and draperies were useful for absorbing sound in large spaces, these materials were just a temporary solution for reverberation.82 Adding rugs or curtains worked for smaller spaces, but for large auditoriums, they were not enough to dampen reverberation.83 Laying carpets, hanging fabrics on walls, and using a lot of cloth or canvas in a room could be costly, not


entirely sanitary, and certainly not fireproof. Moreover, the room’s interior architectural features were covered up by these additions.

Acousticians were not satisfied with the existing situation and so, they turned to experimentation to develop a more permanent means for the control of sound conditions. Architects and builders desired a different acoustical material that could conform to the masonry and that would not obscure interior architectural features.

In the mid-1920s, other kinds of acoustical materials appeared. Acoustical tiles and fiberboards were retrofit to existing buildings or installed in new buildings. For example, “Acousti-Celotex,” an acoustical tile product that was introduced by the Celotex Company in 1925, was

Figure 5. According to the source below, Acousti-Celotex acoustical tile installed on ceiling in G. M. Neely Memorial Theatre /Auditorium, Vanderbilt University, Nashville, Tenn. (ca. 1925). [Photography prohibited inside theater]

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utilized in many building types, such as auditoriums, churches, music rooms, schools, banks, typing rooms, printing press rooms, billiard halls, dining rooms, offices, and hospitals. These types of sound-absorbing materials were made of cork, mineral fiber, wood fiber, sugar cane fiber, or flax fiber—all soft and porous materials, and were prefabricated units. Similar to acoustical felts, acoustical tiles were also used in a variety of rooms, where people assembled to hear music, the spoken word, or where people required concentration or mental application (Figure 5). The Celotex Company advertised acoustical comfort while working, while dining, or while listening to a lecture or sermon, to name but a few activities.

Acoustical tiles were made from materials that were also used for insulation. For instance, the Celotex Company sold insulating lumber before

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entering the acoustical materials industry. Acousti-Celotex was made from the same basic material as their insulating lumber product: felted sugar cane fibers. Acousti-Celotex was distinctive because of the numerous holes that were drilled into its surface to give the tile more sound absorptive properties (Figure 6). The Celotex Company claimed the holes added “about 150% to the absorbing area.” A 1.25-inch thick tile was marketed as absorbing nearly 70 percent of sound.

Acoustical tiles were marketed not only for their good sound-absorbing properties, but also for several other advantages. Tiles were a standard factory-made product, which means they could have a variety of textural finishes; and their properties, such as degree of porosity and absorption, were relatively uniform and consistent. This gave acoustical tiles a feature that could not be altered by the skill or lack of skill of the workers who installed the material, unlike the installation of acoustical felts. In general, acoustical tiles could be applied to any kind of wall and ceiling surface without disturbing the interior construction. They were applied either by nails to wood grounds or wood furring strips; or by casein cement to a suitable plaster or masonry base; or by square-cut nails to a gypsum plaster surface.


93. The absorptive quality of acoustical felts and acoustical plasters did depend on the skill of the persons who installed the material.

94. The Celotex Company sold a cement made of a special casein compound. It came in powder form and only needed to be mixed with water to be ready for use.
Companies asserted that their acoustical tiles could be cleaned using the same methods as ordinary wall and ceiling surfaces. A washable surface was particularly beneficial for sanitary reasons, for rooms used by the public and institutional spaces. Several acoustical tiles, such as “Sanacoustic Tile” (Johns-Manville Corporation) and Acousti-Celotex, had the distinct advantage of being decorated with oil, lead, or any other kind of paint without sacrificing their absorptivity, and

Figure 7. According to the source below, Acousti-Celotex decorated the ceiling and in an ashlar pattern on the walls; it was installed in the radio broadcasting studio of Nelson Bros., Bond & Mortgage Company, Chicago (ca. 1925).


could be repeatedly painted and maintained. The mechanically-made holes in the tiles created a passageway for the sound waves to reach the interior of the tile and be absorbed into the tiny pores of the material. As long as the perforations were not closed over, there was no loss in absorption. Laboratory and field tests proved that the absorptive value of decorated Sanacoustic Tile and Acousti-Celotex was not impaired by paint on their surfaces. The high absorptivity was extremely helpful for rooms that needed to be very quiet, such as movie theaters, libraries, and radio broadcast studios (Figure 7).

The disadvantages to using acoustical tile were its limitations for architectural treatment, its cost compared to other acoustical materials, and the combustibility of several types of tile. It was generally not possible to conceal the joints between adjacent tiles, and so acoustical tiles were limited to only a tile or ashlar effect. It was only on high ceilings that acoustical tile could achieve the appearance of a continuous or monolithic surface through the use of tight joints and by fully decorating the surface. On low ceilings, however, the joints were noticeable with any type of decoration. Therefore, it was customary to create a beveled edge around the tile and accentuate rather than conceal the tile’s masonry effect.

96. See Appendix A for additional images.


In the 1930s, the cost of acoustical tile was relatively high compared to the cost of acoustical boards and plasters. The standard price was between thirty-five and seventy cents per square foot, installed. The wood fiber acoustical tiles were the most economical, but they were also combustible. To comply with code regulations, the acoustical tiles made from organic materials, like wood fiber, were treated with a fire retardant.

Another acoustical material that was applied to walls or ceilings during the 1920s was acoustical fiberboard. In general, acoustical fiberboards were made of pressed fibers of wood-pulp, asbestos, sugar cane, cork, or flax. They were lightweight, porous, and could cover more surface area for a lower cost. Sound-absorbing fiberboards became a viable option for schools and large industrial jobs because acoustical felts or tiles were not always affordable or practical for these institutions. Comfortable sound environments were now available in places where individuals visited occasionally and where individuals inhabited every day, like their homes.

100. See Appendix for table showing costs.
102. The fire retardant used is unknown to the author.
One of the most common fiberboards was Masonite, a wood fiber acoustical board, developed by William H. Mason, founder of the Masonite Corporation (Figure 8). The raw materials came from lumber waste. Following World War I, the growing lumber industry in the United States eliminated large forests, and so, massive amounts of wood waste were being generated. The Masonite Corporation used this wood waste to manufacture fiberboards. A patent was filed for Masonite acoustical board in 1927. Wood chips were put under high steam pressure, reducing the wood to fiber, and then pressed into panels. The majority of acoustical fiberboards came in large boards, four feet wide, and eight, ten, or twelve feet long. Masonite was made

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chiefly of long fibers of longleaf pine and southern gum.\textsuperscript{109} This board had a ribbed or corrugated surface that made it different from regular fiberboard, and the rear surface was smooth but was adapted for studs so that it could be applied to finished walls.\textsuperscript{110} Fiberboards were applied in panels “with suitable strips or ornaments covering the joints.”\textsuperscript{111} This means that panels of acoustical fiberboard were applied to more surface area in less time, and in effect, a room was finished more quickly than if it were finished with acoustical tiles.

The chief advantage of acoustical fiberboards was their cost. In the 1930s at a time of the economic depression, a material that was cost-effective had an advantage. Consumers bought acoustical fiberboards to use in their homes probably because of its cost and ease of installation.\textsuperscript{112} These boards could be hung from picture moldings in small rooms, using the entire length of the board to cover the height and efficiently panel the areas desired.\textsuperscript{113} Panels of acoustical fiberboards provided a simple method of reducing reverberation and a quick method of installation, in comparison to the more time-consuming process of individual tile placement or the measurement of rolls of felt to be applied.

Acoustical fiberboards were made from similar materials as acoustical tiles, but they had drawbacks not generally seen in the tiles. Acoustical fiberboards were less sound-absorptive than the tiles, absorbing about 30 to 40 percent of sound.\textsuperscript{114} But for their value, fiberboards offered a decent

\textsuperscript{109} Vern O. Knudsen, \textit{Architectural Acoustics}, 246. Table XX illustrates the physical properties of absorptive materials, such as the composition, sound absorption coefficients, and thicknesses.


\textsuperscript{112} Mason Fibre Company, “Specifications and Details of Masonite,” Columbia University in the City of New York Avery Architectural and Fine Arts Library (trade brochure, Chicago: Mason Fibre Company, 1926), 3.

\textsuperscript{113} Floyd R. Watson, \textit{Acoustics of Buildings} 2nd Ed. (New York: John Wiley & Sons, Inc., 1930), 61.

amount of absorption. The cost was usually no more than about six to eight cents per square foot, which was modest compared to the costs of other acoustical materials on the market.\(^{115}\)

Also, acoustical fiberboards were not easily decorated.\(^{116}\) Decoration was not usually applied because oil and paint would close the pores on the surface of the material, which would have depleted the absorptive value. However, thin dyes and stains, stencil designs with heavier paint, or dry paint dusted on with a pounce bag were options for decoration that were not supposed to diminish the absorptive value of the fiberboard.\(^{117}\) Lastly, dried cellulose-based materials tended not to do well with combustion and therefore, they were not fireproof.

While innovations in wall-applied materials based on fiber were being made, acoustical masonry materials, generally tiles for walls and ceilings, began to emerge. The development of the first acoustical masonry tile started with the collaboration of two experts in their respective fields, architect and builder Rafael Guastavino, Jr. and physicist Wallace Sabine.\(^{118}\) The architectural firm of Cram, Goodhue & Ferguson introduced Guastavino to Sabine in 1911.\(^{119}\) Cram, Goodhue & Ferguson were aware of Sabine’s study on acoustics and brought in their builder, Guastavino, to work with Sabine to design a material that was stone-like and neo-Gothic in appearance that could reasonably address the acoustical problems in their designs. Guastavino was aware of people’s

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\(^{118}\) Guastavino appears to be the first company to manufacture acoustical masonry tiles, but to name a few other companies that manufactured them were Acoustical Corporation of America, Calicel Products, Inc., Celotex, Certain-Teed Products, F. E. Berry, Jr. & Co., Johns-Manville, and United States Gypsum.

\(^{119}\) Guastavino and Sabine were chosen by Cram, Goodhue, and Ferguson to design a stone-like, neo-Gothic style and sound-absorbing material that could be employed in churches and other religious spaces. For more details of the respective backgrounds and working relationship between Cram, Guastavino, and Sabine, see Emily Thompson’s dissertation or book. This was a significant collaboration at a time when acoustics was not a fundamental principle studied at every architecture school. People still did not understand architectural acoustics and what was needed to have good acoustics, even though Sabine published a number of articles on the topic in 1900.
increasing preoccupation with silencing sounds around them and wanted to capitalize on the potential of developing and selling an acoustical tile that could be installed using the existing Guastavino Tile Arch System.\textsuperscript{120} He wished to improve the acoustic quality of his hard ceramic tile, and so through this collaboration, he was able to get the advice of an acoustic expert. Sabine agreed to help as it was an opportunity to further his research. The collaboration between Sabine and Guastavino proved to be mutually beneficial. Following a series of trial and error, Guastavino and Sabine created the “Rumford” tile and filed a patent for it in February 1913.\textsuperscript{121}

“Rumford” acoustical tile appears to have been used mainly in churches and cathedrals. Many places of worship at the time had problems with excessive reverberation and echo, and this product was hoped to be a solution. The stone-like physical appearance of Rumford (Figure 9), in

\textsuperscript{120} Emily Thompson, \textit{The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933} (Cambridge, MA: The MIT Press, 2002), 181-85.

\textsuperscript{121} W. C. Sabine and R. Guastavino, “Wall and Ceiling of Auditoriums and the Like,” United States Patent 1,119,543, filed February 17, 1913, and issued December 1, 1914.
addition to its fireproof disposition, made it a suitable match for neo-Gothic ecclesiastical structures.

Rumford was ceramic in nature, being a fired product, composed of 25 percent clay, 10 percent feldspar, and 65 percent “vegetable bearing earth,” or peat.\textsuperscript{122} It was applied to the exposed face of walls and ceilings, as the final finish. Its uniqueness was in its pore structure, which was characterized by a series of interconnected air pockets, formed in the kiln during the firing process as the vegetable matter was burned out. The quality of sound absorption was influenced by how prevalent these interconnected channels were throughout the material and whether they reached the top surface and through the interior.

Although it was an innovative material, Rumford was not inexpensive. During the firing process, these tiles lost a considerable amount of material as the vegetable matter burned away, and there was a possibility of the pores coming out covered. The imperfections formed a shell-like skin on the surface that usually occurs in kiln-fired materials. Loss of pores meant the tile’s sound absorptive value could be impaired. To prevent the formation of this skin, Guastavino applied a coating of crushed vegetable bearing earth to the surface of the mold blank, on the side that formed the finished face.\textsuperscript{123} It was expensive to make because it could not be manufactured in the same way as conventional kiln-fired materials like brick or tile or it would result in the closure of its vital pore structure.

Being a kiln-fired material was not the Rumford tile’s only drawback. Its production process was not very efficient and it did not always yield positive results in the characteristics of the tile.\textsuperscript{124}


\textsuperscript{123} W. C. Sabine and R. Guastavino, “Wall and Ceiling of Auditoriums and the Like,” United States Patent 1,119,543, filed February 17, 1913, and issued December 1, 1914.

Furthermore, some of the final units from the kiln came out warped, overly vitrified, or under-fired. And their properties of color, porosity, hardness, and durability were also inconsistent with each production lot. As a kiln-fired masonry material there was generally a variation and an unpredictability to each lot of Rumford tile. But despite these variations, its sound-absorbing quality was felt to be reasonable at the time of its installation. Rumford tile was used in at least three locations in New York City: St. Thomas Church, St. Bartholomew’s Church, and St. Vincent Ferrer Church. Problems with the tile became more evident over time, including its brittleness and its surface qualities that attracted heavy soiling. Its use was short-lived.

Some of the drawbacks with Rumford tile were addressed with Guastavino and Sabine’s next collaborative effort: “Akoustolith” artificial cast stone. It was initially used as Akoustolith tile. Akoustolith was different from Rumford in that it was easier and cheaper to manufacture, and was not a ceramic. Instead, it was composed of a narrow gradation of lightweight pumice or sand aggregates, bonded with portland cement. This means that when it was produced the intercommunicating pore structure was kept intact, as finer grades of material would otherwise fill the interstitial spaces between the aggregate. The limited points of contact between the aggregate ensured the existence of pores.

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126. Guastavino would later develop a plaster with the same name.

127. Akoustolith was patented in 1916, but by 1918, Rumford tile was the only Guastavino acoustical tile advertised in Sweet’s Catalog. Sweet’s Catalog Service, “R. Guastavino Company,” Sweet’s Indexed Catalogue of Building Construction (New York: Architectural Record Co., 1918), 34-35.


Furthermore, Akoustolith was more uniform in its color, composition, and absorptive qualities compared to Rumford, even though both tiles were installed in a similar manner. The recommended proportions were three parts sand or pumice to one part portland cement. If portland cement was used, a sufficient amount of water was required to activate the cement. After these materials were mixed, they were either cut into standard tiles, placed into a mold where the mixture was set, or they were formed into the desired shape without the mold. From here, the interconnected pores formed throughout the material and penetrated the surface. Akoustolith units were installed as one-inch thick panels to exposed surfaces and became the finished face of the walls and ceilings (Figure 10).

Predictability and reliability of an acoustical material’s color, size, texture, and performance were important. As a porous masonry material, Akoustolith was durable and vermin-proof. The color and texture of Akoustolith stone depended on the aggregate and cement used during the

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manufacturing process, and so they were easily controlled. Akoustolith proved to be more economically viable than Rumford. Not at the mercy of a kiln and the unknowns in the kiln-firing method, ensured less material was wasted during the production process. Furthermore, eliminating the kiln-firing process altogether benefited the production costs. Akoustolith would prove to be a better sound-absorber and easier to manufacture. Akoustolith tiles were predominantly utilized in grand spaces. The stone-like and monumental aesthetic of Guastavino’s acoustical tiles were not appropriate for many buildings.

The popularity of acoustical materials grew in the early twentieth century. With its popularity came a market for inexpensive acoustical materials developed to be used in more functional buildings, such as offices, banks, and schools. The acoustical materials boom in the 1920s gave people a wider selection of acoustical materials to choose from, that had various methods of installation and effectiveness.
Chapter 3: Acoustical Plaster

As the search continued in the first quarter of the twentieth century for additional materials to address issues with sound, acoustical plaster came into use. It was a modification of traditional plaster, using some similar materials and many of the application techniques. Acoustical plaster remains a poorly understood material as there were many proprietary formulas that have never been deciphered.

Plaster was a common building material used to finish walls and ceilings in the nineteenth and early twentieth century. In the early 1900s, finishing plaster was almost always gypsum, sand, lime, fiber, and occasionally cement. Gypsum is a soft, naturally occurring water-soluble mineral, known as hydrous calcium sulfate.\(^{131}\) It is found frequently in thick deposits throughout the earth’s surface, in volcanic areas, and in veins of metallic ores.\(^{132}\) Gypsum is made by heating gypsum and then grinding it into a fine, white powder.\(^ {133}\) When mixed with water, it forms a paste-like material.\(^ {134}\)

Gypsum plaster made for a fast-curing interior finish plaster that could be easily worked with a hawk and trowel. It was traditionally applied in three coats and was applied on masonry or lath, usually wood or expanded metal, although by the early twentieth century metal lath was more common.\(^ {135}\) The first layer of plaster, the scratch coat, was theoretically to be applied at 1/4-inch to

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131. Cedar Rose Guelberth and Dan Chiras, *The Natural Plaster Book* (Canada: Transcontinental Printing, 2003), 188.


3/8-inch thickness. It was scratched or scored with a comb after it was nearly set to give a rough texture. Then the second coat, or brown coat, was applied directly to the scratch coat, also at a 1/4-inch to 3/8-inch thickness. Finally, the finishing coat was spread uniformly over the brown coat at 1/8-inch thickness, or at most 3/8-inch, to provide a smooth, durable surface after the paste hardened. However, there were many installations that only used a two-coat plaster system with just the scratch coat and a finish coat.

There are several different types of plaster, but portland cement plaster is the other that is most relevant to the later discussion on acoustical plaster. In the early 1900s, portland cement plaster was generally a combination of portland cement, sand, and occasionally hydrated lime. Portland cement is a fine powder produced by blending, burning, and grinding limestone, clay, and small amounts of other materials. When water is added to portland cement, it forms a plastic mass. It will adhere to a surface and harden over time, resulting in a durable, water-resistant product.

Like gypsum plaster, portland cement plaster was applied using the same tools on masonry or lath. Portland cement plaster was applied in two coats if used over solid masonry or three coats if over expanded metal lath. The application process was theoretically the same as gypsum plaster.

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However, if a two-coat application was used, then the second coat was applied at 1/8-inch thickness to 3/8-inch at most. Again, thicknesses could vary slightly.

Acoustical plaster was based upon modifications of the finish coat of the two- or three-coat, traditional plaster. The finish coat often consisted of pumice, or another lightweight, glassy aggregate, like coke breeze or perlite; gypsum or portland cement; glass fibers, like mineral or asbestos fiber; foaming agents; and water.

There were undoubtedly other ingredients but finding them would require extensive reverse engineering of many mixes and this has not been undertaken or at least

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141. ‘Traditional plaster’ denotes the regular plaster that was used in the early 1900s.


143. Cement or gypsum were common binders, but other binders were magnesite, lime, or special preparations developed by the manufacturer [Vern O. Knudsen, *Architectural Acoustics* (New York: John Wiley & Sons, Inc., 1932), 192-93]. Fibers were part of the “combination of other materials” used in mixtures, but exactly what this combination was, was not usually specified in the product’s description given by the company. In addition to pumice, sometimes another porous material was added to the mixture, like cork particles [Napoleon M. Bernier, “Acoustical Plaster or Tile and Method of Making the Same,” United States Patent 2,005,069, filed Apr. 28, 1932, and issued June 18, 1935].

the author has no knowledge of this having been performed.\textsuperscript{144}

Acoustical plaster was applied with a hawk and trowel over traditional base coats of plaster. It was built up in a series of coats until the desired total thickness was reached. Usually, manufacturers called for thicknesses of $\frac{1}{2}$-inch or 1-inch.\textsuperscript{145} For a $\frac{1}{2}$-inch finish coat, the initial layer of acoustical plaster was applied $\frac{1}{4}$-inch thick, then doubled up with another $\frac{1}{4}$-inch layer thereafter. This finish coat was not smooth as the pore structure was very integral to this finish (Figure 11).

Acoustical plaster was defined by its sound-absorptive properties that were a result of these pores on the surface and throughout the interior of the finish coat. The sound-absorbing properties of acoustical plaster were a product of the pores and aggregate used. Pumice was one of the more common aggregates for acoustical plaster. Pumice has been used in concrete since ancient Roman times for its lightweight qualities, but presumably pumice was a common aggregate because large deposits were found in California and large quantities were imported from Italy in the early 1900s.\textsuperscript{146}

The open cellular structure formed on mixing and installation, creating interconnected pores.\textsuperscript{147} There were pores in and around the pumice aggregate particles. The more or less sharp

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{voids.png}
\caption{Voids formed between particles as a result of the more or less sharp projections of the aggregate. Source: Paul E. Sabine, “Sound Absorbing Plaster,” United States Patent 1,458,631, filed April 29, 1921, and issued June 12, 1923.}
\end{figure}

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\textsuperscript{145}. The thickness varied depending on the job and how much acoustical plaster was deemed necessary by the acoustic engineer, to provide the sound conditions desired.


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projections of the aggregates prevented close packing, resulting in a material with voids in between the particles (Figure 12). The irregularity of the surface and the pores that reach through to the surface from the depths of the material, aided the porosity of acoustical plaster. The theory as to how acoustical plaster worked was that sound energy would be able to travel through the surface pores and into the plaster where it was then absorbed and dissipated into heat.\textsuperscript{148} But if the surface were troweled smooth, then the pores on the surface would be closed up. The voids in the body of the aggregate itself were beneficial to the sound-absorbing properties of acoustical plasters in this way. The end product was a porous surface, or a plaster with good sound absorptive properties. (On average, acoustical plasters absorbed 20 to 40 percent of sound, but could absorb more if applied in a thicker layer.\textsuperscript{149})


A precise identification of who invented acoustical plaster is yet to be found, but Dr. Paul E. Sabine, a physicist at Riverbank Laboratories in Geneva, Illinois, was one of the first to patent an acoustical plaster in 1921.\(^{150}\) (In 1926, Dr. Sabine was officially credited as the inventor of “Sabinite, a sound-absorbent plaster.”)\(^{151}\) He created acoustical plaster with the intention of providing a material that could be applied with ordinary plastering tools, and that when set, would absorb much more sound than traditional plasters were capable of.\(^{152}\) In his patent, Dr. Sabine indicates that buildings needed to be constructed with materials that could absorb sound and that it was a necessity for buildings to be constructed with materials that could absorb sound and that it was a necessity for

\(\text{Figure 13. M. A. P.'s Sweet's Catalog entry.}\)


\(^{150}\) 1921 was the earliest year the author found a patent from. (Paul Sabine was a distant cousin of Wallace Sabine.)


The patent does not specifically mention maintenance needs, however an article from the \textit{The Science News-Letter} suggests that Dr. Sabine had places with sanitary needs in mind when he invented it. He remarked, “Proper sanitation and satisfactory acoustics are apparently mutually antagonistic.” Dr. Sabine seems to have wanted to rectify the situation of the unavailability of an acoustical material that could potentially be cleaned.
“auditoriums and the like” to “secure proper acoustical conditions.” In fact, other patents discussed that acoustical plaster was created with the intention of minimizing echoing effects in auditoriums and other rooms as well.

Dr. Sabine was not the only one working on acoustical plaster. Other manufacturers, such as the Mechanically Applied Products Company (M. A. P.), had research teams developing acoustical products. By 1922, M. A. P. had the first acoustical plaster to be advertised in Sweet’s Catalog, “Macoustic Plaster” (Figure 13). This acoustical plaster was developed as a result of architect J. H. MacDowell’s need for a sound-proofing material. MacDowell, as the architect for the Cleveland, Ohio municipal auditorium, refused to use an expedient, sound-deadening felt on the walls or ceiling. Instead, MacDowell collaborated with the Mechanically Applied Products Company to develop a sound-absorbing plaster. According to Henry Roegge, the president of M. A. P., the company worked with MacDowell for eighteen months, testing “a hundred or more” plastered panels and various compositions until they found the one most suitable for the city auditorium. Roegge acknowledged that their Macoustic plaster was not as sound-absorbing as other acoustical

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154. Ibid.


156. The composition of Macoustic was never stated in the company’s trade brochures or Sweet’s Catalog entry. Presumably, the company wished to keep it a secret. Usually, Macoustic was described to be a “plastic material applied like plaster.”


157. Ibid.
materials typically used, but given the choice to cover the area with semi-absorbent material versus smooth, hard traditional plaster, the better result was obtained using the former.\(^{158}\)

Other than for sound-absorbing purposes, acoustical plaster was developed for economic considerations and its ease of application.\(^{159}\) It was relatively inexpensive material to install: on average, acoustical plaster cost just one to two dollars more per square yard than traditional plaster.\(^{160}\) And acoustical plaster was also cheaper to install when compared to the other acoustical treatments available. Acoustical plaster cost 2.50 to 3.00 USD per square yard installed whereas acoustical felt or tile treatments ranged from 5.00 to 9.00 USD per square yard installed.\(^{161}\)

Acoustical plaster was installed by plasterers as it was similar to traditional plaster in application. No special equipment was needed for installing acoustical plaster—the tools required were those used by regular plasterers.\(^{162}\) (By comparison, acoustical felts and tiles needed nails or metal furring strips for attachment to walls or ceilings.) Moreover, acoustical plaster was applied in a similar way to traditional plaster, so this meant that plasterers were able to use a system familiar to them.


Fireproofing was perhaps not the key reason acoustical plaster was developed, but it was an important characteristic. Patents do not state that the plaster was made for fireproofing reasons. This may be because plaster was already known to be fire-resistant. The fireproof quality of acoustical plaster was more of a selling point for manufacturers. Fire safety was an important issue in this period and all acoustical plasters were essentially fireproof.

There were generally two types of acoustical plaster offered by manufacturing companies, gypsum or portland cement. Gypsum acoustical plaster was for general usage over walls and ceilings. Its two main known components were pumice and gypsum plaster, which was applied over a gypsum-based scratch and brown coat. Products like Kalite (Certain-Teed Products Corp.), Macoustic (M. A. P.), Stucoustic, Type A.D. (California Stucco Products Co.), and Sabinite A (USG)

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Following events like the Great Chicago Fire of 1871, Iroquois Theater Disaster of 1903, and the Triangle Shirtwaist Factory Fire, new reforms were made to ameliorate fire safety standards. The 1911 Triangle Shirtwaist Factory Fire caused the deaths of 145 people. The death of the victims could have been easily prevented—most died as a result of neglected safety measures and locked doors within the factory building. As a result of this tragedy, many cities enacted reform to prevent any future disasters. These events and the hundreds of deaths they caused could have been avoided had the spread of fire been prevented by structures built with proper fireproof materials.

were made of mostly pumice with a gypsum binder. A variation on the gypsum acoustical plaster was cast acoustical plaster. This was a gypsum-pumice mixture used for plain and ornamental design and relief work. Castacoustic (Guastavino Co.), Kalite Cast (Certain-Teed Products Corp.), Casting Sabinite (USG), and Stucoustic, Type A.C. (California Stucco Products Co.) were some of the acoustical casting plasters. While small castings could be shop-made, Guastavino’s Castacoustic plaster was often cast on site, such as at Pepper Hall in the Franklin Institute (Philadelphia, Pennsylvania).

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Casting acoustical plasters worked similarly to regular casting plasters of the time. The plaster was poured into molds with a canvas backing pressed lightly into the back of the mold. Company catalogs state that this was a plaster for casting purposes, but do not state how it was made. Architects or engineers might be able to look at the cast and reverse-engineer the process.

The other acoustical plaster mixture was pumice aggregate with a portland cement binder for general use in places of high humidity. Portland cement acoustical plaster was applied over a portland cement-based scratch and brown coat. Manufacturers advised a portland cement acoustical plaster be used if it was applied in an area subjected to high humidity or periodic wetting. For instance, Guastavino’s Akoustolith plaster was used on walls and ceilings exposed to dampness, such as those in swimming pools or steam kitchens. Kalite Hydraulic (Certain-Teed Products Corp.) and Sabinite No. 38 (USG) were also used for this same purpose.

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In the 1920s and 1930s, acoustical plasters were used predominantly in new construction. Macoustic, Akoustolith, and Kalite plasters were initially used for acoustical correction in large spaces that people visited, but did not inhabit continually. Other than good acoustics, the monumental appearance of acoustical plaster was particularly suited to auditoriums, concert halls, and churches. Some architects considered acoustical plasters architecturally more substantial than other soft acoustical materials of the early 1920s, because acoustical plaster was fireproof and offered a seamless finish without any covers on the joints.\footnote{171} One of the earliest recorded uses of acoustical plaster was Macoustic (M. A. P.) in the Cleveland Auditorium in 1922 (Figure 14). The seating capacity was advertised to be 15,000, and, at the time, Cleveland Auditorium claimed to be “the largest building in the world ever treated acoustically.”\footnote{172} The Cleveland Auditorium was designed and equipped to serve various functions for entertainment and exhibition, like athletic competitions, balls, pageants, plays, musical concerts, and religious functions—an entire variety of activities with varying sound requirements.\footnote{173} These requirements were also found in places of worship, which also used acoustical plaster. Some examples are the Riverside Church (New York City, Henry C. Pelton and Allen & Collens, architects), Church of Saint Andrew and Saint Paul (Montreal, Canada, H. L. Fetherstonhaugh, architect), and Appleton Chapel (Cambridge, Mass., Coolidge Shepley, Bulfinch & Abbott, architects).\footnote{174}


But besides the monolithic appearance of acoustical plaster that suited these spaces so well, the lightweight, structural quality of acoustical plaster was also significant, especially for large buildings. Kalite sound-absorbing plaster was utilized, perhaps most notably, in Radio City Music Hall (Edward Durell Stone, architect) in 1932 (Figure 15). Radio City Music Hall was a symbol for what could be accomplished even in a time of economic depression. The “golden” buff-colored ceiling and the 6,000 seat capacity of Radio City Music Hall could provide a decadent escape for a gloomy nation. Public rooms needed good sound quality to maintain attendance. If people were satisfied with the acoustics, then they were likely to return.

During the Depression, the simple, efficient appearance of acoustical plaster was fitting for usage in everyday spaces. Over this period, acoustical plasters, like Sabinite and Stucoustic, were

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typically used for noise quieting in places inhabited every day for long periods of time. The decrease in noise levels led to improved working conditions and worker efficiency because there were fewer distractions. Sabinite could be found in schools, offices, lobbies (Figure 16), and particularly in stenographic departments, where as many as 60 typewriters were in constant operation. Stucoustic, too, was used at a number of high schools and universities, such as Dartmouth Hall at Dartmouth College (Hanover, New Hamp.; Jens Frederick Larson, architect), the Physics Building at M. I. T. (Cambridge, Mass.; G. T. Richards, architect), and Glen Cove High School (Long Island, NY; Tooker & Marsh, architects). Students and workers still required mental application for their tasks, and acoustical plaster could provide a comfortable aural environment for them to do so.


178. Further investigation is needed to determine whether the acoustical plaster still exists in these structures.
noise quieting, it was used for other reasons, such as in Scotty’s Castle it seems to have been used for acoustical correction. Today, this acoustical plaster remains in Scotty’s Castle (Figure 17), in what used to be the summer home of Albert and Bessie Johnson, a wealthy couple from Chicago. Scotty’s Castle was built over nine years, from 1922 to 1931. The acoustical plaster was purchased in 1927, to be installed in the Upper Music Room of their home.¹⁷⁹ The Johnsons used this room to entertain their many guests. People gathered here, and Bessie Johnson used the room to give her sermons. Organ concerts were held in this room as well.

![Figure 17: Stucoustic acoustical plaster (with detail) installed on the walls of the Upper Music Room, Scotty’s Castle, Death Valley, Calif. (View from room entrance)](image)

Source: Photograph on left by the author, 2014. Detailed photo on right courtesy of Gretchen Voeks, National Park Service

Acoustical plasters could be tinted with color or finished with a texture. Although the natural color of most acoustical plasters was a neutral gray, most plasters could be tinted almost any color before application.¹⁸⁰ For example, Sabinite could be furnished in white and four standard colors or tints: ecru, ivory, cream, and buff.¹⁸¹ Others, like Stucoustic, could be spray-painted or


integrally colored.\textsuperscript{182} Spray paint supposedly did not fill in the surface pores as it was only a thin layer of color.\textsuperscript{183} Adding a textured finish was believed to improve the material’s sound-absorptive qualities. Acoustical plasters had the option of being floated, stippled, textured, or antiqued, if

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure18.png}
\caption{Examples of some surface textures}
\textit{Source: The Guastavino Fireproof Construction Company/George Collins architectural records and drawings, Department of Drawings & Archives, Avery Architectural & Fine Arts Library, Columbia University.}
\end{figure}


desired (Figure 18).\textsuperscript{184} These methods increased the surface area to allow more exposure to air in the setting and drying process, and to allow more sound to reach the interior of the plaster to increase efficiency.\textsuperscript{185}

However, acoustical plaster was not without its faults. While acoustical plaster was a hard material in comparison to the fibrous acoustical felts and tiles, as a building material it was friable and if abraded by something it came into contact with the surface was marred. Also, the surface soiled easily and soiling settled deep within the pores. Thus, acoustical plasters were actually quite difficult to clean properly; they could be washed of the dirt and dust they inevitably collected, but not without abrading the surface. The portland cement acoustical plasters fared better than gypsum acoustical plasters\textsuperscript{186} in this regard—that was why cement plasters were recommended for places with sanitary needs, like hospitals and medical centers.

Issues with the physical properties were not the only concerns, however. There were sound-absorbing problems related to the installation process and the decorating process. The porosity of acoustical plaster was in part dependent on drying conditions and on the suction behind the plaster. A high degree of suction from the drying out of the finishing plaster influenced the success or failure of the plaster’s sound-absorbing properties. The scratch and brown coats were supposed to draw the water from the acoustical plaster, and thus “prevent the formation of a nonporous film on


\textsuperscript{186} Plasters that are portland cement-based develop their strength over time. They form a hard outer skin. Hardening is a result of carbonation, which is the incorporation of carbon dioxide into the plaster. Yvonne Dean, \textit{Finishes 4th Ed.} (London, England: Longman Limited, 1996), 83.
the finished surface.”\textsuperscript{187} If a nonporous film in the form of pigment paint was applied, it adversely affected the quality of the material as well. No acoustical plasters could be brush painted with regular oil varieties as this would close up the pores on the surface and deplete its sound-absorbing properties.\textsuperscript{188} Because painting acoustical plaster required careful application, manufacturers either offered exact painting instructions or they had a supervisor visit the site to ensure that paint was applied properly.\textsuperscript{189}

Prior to the invention of acoustical plaster, architects and builders may have refrained from using acoustical materials because of economic or fire safety reasons, but by the 1920s, sound-absorbing plasters were available and affordable. Its widespread use helped people become accustomed to sound-conditioned environments. While acoustical plasters were popular, their maintenance was discovered to be expensive and difficult. The dirt was unsightly, and so people began to paint over it to improve the aesthetics. Unfortunately, after numerous coats of spray paint, there was a significant reduction in the acoustical plaster’s efficiency. Companies, like California Stucco Products, warned that five layers of spray paint could reduce sound absorption by two percent.\textsuperscript{190} Furthermore, the durability manufacturers promised was not always accurate; pieces of plaster could crumble off with a bit of pressure to the surface. The amalgamation of these issues negatively impacted acoustical plaster as an effective sound-absorbing material. Thus, these early


variations of acoustical plaster became a less popular choice by the early 1940s. Issues with maintenance and repair remain. They are very much at the forefront of today’s challenges with the preservation and conservation of acoustical plaster.

Chapter 4: Preservation of Acoustical Materials

Preserving acoustical materials is difficult. The materials vary in type and condition. Also, many of these materials have already been lost to deterioration and changing fashion. The questions that need to be addressed are not only why one would preserve acoustical materials, but how one can do so.

The first step in documenting acoustical materials is identifying the material. Distinguishable features are given below. Overall, these acoustical materials were available in a variety of colors and may have a painted or unpainted surface.

**Felts**

Acoustical felt is soft and looks like a blanket of matted, condensed, and pressed fibers; the membrane that covers the felt is a canvas or cloth that could resemble a plaster or tile surface. Early twentieth century variations were not particularly durable and are less likely to be found today.

**Fiberboards**

Acoustical fiberboards are large, semi-rigid or rigid panels with a fibrous appearance and may even look like conventional wood on the surface. They are mounted by nails or an adhesive. Similar to acoustical felts, fiberboards from the early 1900s are less likely to be found today.

**Tiles**

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192. In addition to visual identification, laboratory testing may be required. It may be necessary to take a sample of the material, which is considered to be destructive. If a sample is needed, conservation practices dictate that it be taken from an inconspicuous place. Some options for testing the material are polarized microscopy, X-ray diffraction, and petrographic analysis.

193. See appendix if additional visuals are needed.


Fiber tiles have mechanically-made perforations on their surface with noticeable joints as they are usually limited to a tile or ashlar effect. The various fibrous tiles are semi-rigid or rigid and could have been painted. Most fiber tiles were applied by gluing or nailing to wood furring, plaster, or concrete substrates, or by fastening to a suspension system. According to Anne Weber, the most prevalent type was application with an adhesive.

Acoustical masonry tiles tend to imitate stone aesthetically, but are more lightweight in comparison. They have a fine or rough, granular appearance with noticeable joints, and were applied directly to masonry. The tiles were available in shades of gray and buff. And since they are fireproof, they are typically found in large public, historic spaces.

**Plaster**

Acoustical plaster looks like plaster but with a more irregular texture; its surface may be floated or stippled. It forms a seamless porous surface, unbroken by tile lines. Similar to acoustical masonry tiles, it is lightweight, fireproof, and can be found in historic spaces. Also, acoustical plaster is softer and easily abraded.

Acoustical materials should be preserved where possible. Reasons to preserve early twentieth century acoustical materials lie mostly in their age, historic value, and function. The materials discussed in this thesis are almost a century old and should be kept intact because the acoustical materials were, historically, a part of and essential to a space. They are crucial to the story of a space.

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as they present information in a visual way. Additionally, there are guidelines for the treatment of historic materials. The Department of the Interior recommends that historic sites identify what the materials in their space are,\textsuperscript{199} and they insist on not altering materials in order to preserve or save the historic character of the site. The standards for preservation given by the U. S. Department of the Interior state, “The replacement of intact historic materials or alterations of features that characterize a property will be avoided.”\textsuperscript{200} Interior features and finishes play a prominent role in the history and significance of a site, and if altered or removed, then information about the site might be lost.

Furthermore, these early twentieth century acoustical materials are significant because they may be one of the few left in use. Acoustical materials dated to the early decades of the 1900s are unique in that they are not commonly extant.\textsuperscript{201} Historic acoustical materials may not be found in spaces today because these materials were constantly being updated or were discontinued, and replaced over time.\textsuperscript{202}

Acoustical materials are also significant because they were specifically selected for their environment. They were used in many types of rooms, but were not used just anywhere—they serve a function. Acoustical materials were engineered for the particular purpose of providing good acoustics. And their impact as such should be noted and preserved.


\textsuperscript{201} Historic acoustical masonry tiles and acoustical plaster might be more commonly seen today, probably because they are more durable.


Acoustical materials should be preserved for the value they bring to the space in which they were installed and conserved to meet society’s current needs. Therefore, the form of treatment that works is one that is appropriate and economically feasible for the client in question. The least amount of intervention is usually appropriate. The material should be left untreated if intervention might damage it or mostly untreated if there are no issues with it; that is to say, not all acoustical material can be preserved due to its condition. Routine maintenance should occur to retard deterioration or to prevent damage.

However, there are exceptions to this philosophy. As discussed in documents, such as the Venice Charter and AIC Code of Ethics and Guidelines for Practice, the integrity and historic feature of these materials need to be respected, but an approach that does not take into account life/safety, economic, or social demands of the future is unacceptable. If the material is hazardous, these hazards either must be removed or the material must be modified to eliminate any risks to the public.

If the material is in poor condition, e.g. vermin-infested felts or moldy materials, it is not functioning and components of its aesthetic character have been compromised. To fix this, the acoustical material should be retained and repaired to a workable condition. The repair should be as least invasive as possible. According to Article 10 of the Venice Charter, repairs should be completed using the same or similar traditional techniques and if these techniques prove inadequate,

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203. Material integrity and/or preservation decisions regarding the future are discussed in Article 5 of the Venice Charter and Articles III, VI, XII of the AIC Code of Ethics.

then modern techniques can be used only as long as scientific data and experience prove their
efficacy. But in reality, repairing or cleaning many acoustical materials would be very expensive. The
process is costly, both financially and to the material itself. Damage to the material can occur in the
cleaning process and the porous nature of the material leaves internal spaces of the acoustical
materials inaccessible to cleaning, not allowing for the full abatement of biological issues.

Issues with health and safety must be addressed. Some of the fiber-based acoustical materials
can be made with asbestos. Others can have mold. A test to determine if asbestos is present should
be completed before any treatment takes place, as it is known that asbestos was used in some
acoustical materials.

Acoustical materials with asbestos or mold can be difficult to salvage or it is inadvisable to
salvage them. An asbestos abatement team would have to be consulted in matters of the
preservation of a historic acoustical material that contains asbestos.205 If asbestos is present, laws and
regulations state that asbestos must be abated or encapsulated.206 Asbestos, even at low levels, has
various health risks associated with its exposure.207 The concern is about people being exposed to
airborne asbestos and breathing in tiny fibers. The fibers are very small and sharp, and can be
embedded in the lung.208 Asbestos can cause lung cancer and mesothelioma, or cancer of the lung
lining and chest wall.209

205. There are also instances where the abatement team has already gone through a space and removed possibly
historic material containing asbestos before the conservator has even arrived.


207. United States Environmental Protection Agency, “Asbestos Health Risks,” EPA, last modified Feb. 5,

208. United States Environmental Protection Agency, “Asbestos Health Risks,” EPA, last modified Feb. 5,

209. United States Environmental Protection Agency, “Asbestos Health Risks,” EPA, last modified Feb. 5,
Although the health risks associated with exposure to mold are mild compared to asbestos, mold can still cause a variety of health effects. In healthy people, mold can cause coughing or wheezing, nasal stuffiness, or eye, skin, and throat irritation. In immune-compromised people, serious lung infections and other respiratory illnesses can occur. Moreover, continuous exposure may result in poisoning caused by the toxins in the mold and even cancer. Acoustical materials with asbestos and mold cannot be saved or they can be very difficult to save, but in cases where there is little or no risk to health and safety, acoustical materials should be preserved.

Moisture can cause acoustical fiberboards and fibrous tiles to expand or warp. Other than what was discussed in previous chapters, further research of the specifics of how each type of acoustical material decays is needed. Due to the nature of acoustical materials, deterioration varies for each material. Products made from organic materials, like plant or animal fibers, deteriorate over time and are susceptible to biological attack.

Therefore, when they cannot be preserved, then documentation—which is an essential part of the preservation process—and replacement may be the only viable preservation treatment given the problems and even safety hazards with some of the acoustical materials. According to the AIC Code of Ethics, Article VII, documentation creates a permanent record. It informs posterity of the decisions made, which types of treatment were used and why.


If an acoustical material is essential to the space, but there is too much deterioration or damage to the original to function properly and arrangements cannot be made to salvage them, then a replacement is acceptable. According to the Venice Charter and the AIC Guidelines for Practice,\textsuperscript{214} the integrity of the space must be upheld by clearly indicating where compensations were made so that it does not falsify the historic evidence.\textsuperscript{215} Replacements should be reversible, partly because in the future, another material may become available that works as a better substitute for the replacement.

The preservation approach for historic acoustical materials is complex in that it is dependent on the aesthetics, on material requirements and issues that that particular material might have, on sound requirements of the room in which they are installed, the schedule to complete the project, a client’s budget and expectations, etc. Each case is unique and should be evaluated individually, and due to the number of possibilities and to time constraints, only a select few case studies, materials (acoustical plaster, masonry tile, and fibrous tile), and their preservation approach, from the least intervention to most intervention, will be discussed.

It is important to keep as much of the original acoustical material intact as possible, so there are times when the proper preservation approach is to leave the historic acoustical material untouched. The condition of the material should still be assessed as often as deemed necessary by the conservator, but otherwise, the best method may be to keep interference at a minimum. For example, the acoustical plaster in Scotty’s Castle, a historic house museum located in Death Valley


National Park, has not been treated. There are no records of treatment documented for the acoustical plaster at Scotty’s Castle prior to 2007. This acoustical plaster was installed in 1927 and was used on the walls of the Upper Music Room because the room functioned as a place for music performances, such as organ concerts, or the spoken word. Presently, the Upper Music Room is used as a stop on the guided tours of Scotty’s Castle and for organ concerts once a year.

This preservation approach is acceptable because the acoustical plaster retains its original historic character, material integrity, function, and appearance as it is not being altered or damaged in any way. This approach preserves the technology that is original to the house and to the time when it was built. Intervention that alters the aforementioned aspects would not be in line with author’s philosophy and the preservation principles discussed in documents like the Venice Charter and the AIC Code of Ethics.

This treatment option was chosen at Scotty’s Castle because the condition of the acoustical plaster is fair to good, soiling is not a major issue, and it poses no threat to human safety. This approach is also cost-effective and there are little to no external forces affecting its condition that would lead to costly treatment and repair. Now and then, the museum staff has noted that tiny pieces of the acoustical plaster have crumbled off from the walls onto the floors or furniture, but the issue of friability has not been deemed severe enough to require treatment. Acoustical plaster is soft enough that it could be damaged upon forceful contact—from furniture movement or surface

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216. Gretchen Voeks, curator at Scotty’s Castle, stated that there are no records of which treatments, if any, were utilized on the walls prior to 2007. Gretchen Voeks, e-mail message to author, March 27, 2015.

217. Specifically, Articles 3 and 6 of the Venice Charter, and Articles II and VI of AIC Code of Ethics.

218. More recently (April 2015), however, the curator of Scotty’s Castle, Gretchen Voeks, has communicated through e-mail with the author that there are plans to re-assess the acoustical plaster’s condition.
cleaning—but there are few issues with the acoustical material here and, with care in curatorial maintenance, it will remain in fair to good condition.\textsuperscript{219}

Another issue comes from the possible method of repair to be used on damaged plasters. Methods of consolidation can maintain the material and structural integrity of acoustical plaster; however it diminishes or removes its effectiveness as an acoustical material.\textsuperscript{220} In other words, common consolidation treatment will unacceptably alter the original character of the historic acoustical plaster. Should the acoustical nature of the plaster be deemed non-contributing to the significance of the space, it is advisable to conduct additional site-specific study before utilizing consolidation to understand the permanent changes that would occur within the plaster structure and chemistry. In most cases, by not treating the acoustical plaster, its integrity is being protected.

There are cases, however, where an acoustical material requires cleaning treatment to ensure its preservation. For instance, a cleaning treatment was used at Temple Emanu-El, a prominent Jewish synagogue located on the Upper East Side in New York City. The acoustical tiles (Guastavino’s Akoustolith) were installed on the 103-foot high ceiling and walls where speech intelligibility is important. Over time, these Akoustolith tiles collected a “measurably thick”\textsuperscript{221} layer of soil on their surface and needed to be cleaned because dirt clogs the pores of the tiles and affects the acoustical and aesthetic quality. Temple Emanu-El underwent a full-scale restoration in the late-2000s and cleaning was part of this process.\textsuperscript{222}


Cleaning is acceptable because it directly preserves the function and aesthetic of an acoustical material. After a methodical testing process of various cleaners, including dry cleaning, wet cleaning solutions, chemical solutions, foam-pellet sandblasting, and a vacuum-spray combination, conservators picked a dry cleaning method because this approach did not damage the material or change the appearance or porous quality of the tile. Using a dry method fits with the philosophical principles discussed earlier because dry cleaning is able to clean the material without imposing risk of extended damage.

Conservators used Wishab sponges, which are dry sponges that absorb dirt and can be used on sensitive surfaces. Wishab sponges are an appropriate solution; they facilitate a more controlled and gentle cleaning. Methods that do not use water or methods with minimal water introduction are typically the method that works best for cleaning historic acoustical masonry materials, for the aforementioned reasons and because the dirt is not further drawn into the material.

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223. Wet cleaning solutions, chemical solutions, foam-pellet sandblasting, and a vacuum-spray combination all either did damage to the material or left the wall moist, which could mean residue is left within the pores. These would not be acceptable forms of treatment.


224. This method was also employed at the National Academy of Sciences in the 2010-2012 restoration.


225. Chemical cleaners and wet methods should be avoided as they tend to absorb into the surface before they have time to react with the soiling, or chemical cleaners may be too strong and damage the acoustical material. Additionally, using water or a water-based cleaner in liquid form has the potential to leave tide lines on the porous acoustical masonry material. These are ineffective ways to preserve the material.

Poultices, like latex poultice Arte Mundit®, are also used for cleaning soiled surfaces and keep the amount of water used at a minimum. Arte Mundit® type 1 was utilized at the Franklin Institute, a science museum and center of scientific education and research, in Philadelphia, Pennsylvania. 226 Specifically, the Akoustolith on the dome of Franklin Hall had collected a lot of dirt and grime over the years and was restored. 227

Arte Mundit® preserves the aesthetics and function, and it is acceptable because the material integrity is not altered or damaged by this cleaning method. Even though Arte Mundit® can stain, 228 it works well on soiled surfaces for the same reason as the Wishab sponge—it is an appropriate cleaning treatment that is controlled and gentle on the material. Arte Mundit® type 1 is a “dispersion of modified rubber;” 229 it is applied as a liquid and as it cures, it turns into an elastic film. The latex is able to get into the crevices to grab and subsequently hold the soiling to allow for easy removal. After it is pulled from the surface, any staining or residue should be removed and the surface neutralized with a damp sponge or water rinse. 230 In addition to the limited amount of water

228. Almost all of the cleaning products that were tested stained the Akoustolith. As staining mars the surface of the material, it should certainly be removed or at least its damage should be minimized if removing it in its entirety is not possible. This is why it is important to test cleaners.

used, poultices provide prolonged contact with the soiled area, or have long dwell times, which means there is time for soiling to adequately be pulled from the surface and onto the latex.\textsuperscript{231}

Coating an acoustical material is not usually deemed acceptable because the sound-absorbing properties are altered, but an exception can be made when an acoustical material is coated in order to preserve its ultimate use in the structure. For example, this is the preservation approach at the Washington National Cathedral (WNC), the second largest cathedral in the United States, located in Washington D.C. In the 1920s or ‘30s, Akoustolith tiles were installed in portions of the ceiling\textsuperscript{232} to absorb sound and to improve speech intelligibility. While the tiles’ sound-absorbing qualities worked well for speech, they negatively impacted musical performances, like the choir and organ, by deadening too much sound.\textsuperscript{233} Recently, the WNC wanted the acoustics to complement the music and new organ, according to the 2013 Akoustolith assessment by Building Conservation Associates (BCA).\textsuperscript{234} Over time, technology changes and improves, so there was no longer a need at the WNC for the Akoustolith to absorb sound.\textsuperscript{235}

While acoustical materials began as sound absorbers to suit the needs of the early twentieth century, they can continue to suit the needs of the present by being modified. However, they should only be modified for a particular space if this space cannot specifically function without good


\textsuperscript{234} With improvements to technology, the ability to better hear and understand spoken word is not much of an issue anymore.


\textsuperscript{235} The issues with understanding the spoken word are no longer a problem today.
quality sound. This seems to be the case with the WNC, and so coating is acceptable in this instance\textsuperscript{236} and is a reasonable solution to the new problem. After many tests and consultation with an acoustics firm, BCA picked a clear coating that provided the acoustical performance, or sound-reflective properties, needed for a space like the WNC and that did not significantly alter the Akoustolith’s appearance. Coating the acoustical material to be more sound-reflective is irreversible, but this would allow the acoustical material to once again serve its ultimate purpose of providing good acoustics. The BCA conservators decided on the modification that was the least invasive, that preserved the Akoustolith’s surface finish and its function of providing good acoustics.

Maintaining as many elements of the original historic acoustical material is important, but sometimes, it is safer to modify or replace an acoustical material if it contains materials that are extremely harmful to people.\textsuperscript{237} The John Coltrane House\textsuperscript{238} in Dix Hills, New York is an example where this approach was employed. The acoustical tiles were installed in the basement on the walls and ceiling.\textsuperscript{239} (It should be noted that the acoustical tiles are believed to have been put in sometime during or after the 1960s, as this was when John Coltrane and his wife Alice moved in and had a recording studio built.\textsuperscript{240}) This area served as the recording studio of John Coltrane, a famous jazz musician, and was a significant part of the House as Coltrane utilized this space to record his music.

\textsuperscript{236} The conservators of BCA contemplated various options to resolve this issue of whether or not to coat. Options like plastering over the Akoustolith, or covering over the Akoustolith with concrete block or stone, or fully replacing the Akoustolith.


\textsuperscript{238} One of the homes of famous jazz musician John Coltrane.

\textsuperscript{239} Based on historic photos of the John and Alice Coltrane Home.

Mold caused a lot of damage to the acoustical tiles to the point where they are in such poor condition that they cannot be preserved. If possible, the author suggests salvaging any original part that can be salvaged, as long as it does not pose future dangers to life/safety. If the house becomes a functioning museum, many visitors could potentially be walking through the house. It would be a risk to keep moldy materials even if they are original. This is where documentation of the material is absolutely crucial. Even though the original acoustical material itself is not extant, at least there is a record of its use.

If funding permits, a way to mitigate this loss is to replace the acoustical tiles in-kind or to replicate a similar-looking material to be placed back to where they were installed previously. While this may not be the ideal solution, there will be instances where it is okay for a historic material to be replaced and some aspect of the material preserved in another way.

The goal of preserving historic acoustical materials is to use the least obtrusive but effective method. Acoustical materials from the early twentieth century are important because they were engineered not only for aesthetic reasons but for the specific function of providing good acoustics. Moreover, they are an essential part to the story of a space. These are original materials that are almost a century old and so, they have value in their age and their use. However, there is not one set way of preserving them. As the needs and issues of each acoustical material vary, the decision for treatment must be evaluated on a case-by-case basis. And although each situation is different, the method and material should always be documented.
Conclusion

Public and private spaces in mass utilized the advancements of acoustical materials. These acoustical materials represent a new technology that was available at a time when the nation was growing rapidly and sound requirements were changing. They symbolize mankind’s ability to control sound and are a significant component of the interior finish of spaces where sound quality is important. The effects of using these materials were improvements in understanding the spoken word and music, and an environment where people could concentrate, be efficient, and comfortable—where counterproductive noise was reduced or eliminated.

Early twentieth century acoustical materials had a major impact on the building industry and as such, they should be preserved. Even though there are many ways to preserve a material, the approach is about finding the right balance between preservation of the original material and its ultimate function of optimizing sound quality.

This thesis provides a start into the study of the history of early twentieth century acoustical materials. It is a complicated topic to delve into as there is very little technical information and even less on the exact origins. This thesis attempts to cover some of those origins; however the discussion is limited by what has been documented already and by the information the author has access to. Acoustics incorporates many disciplines, but mostly focuses on physics, engineering, and architectural design. This is the side that has been written about and discussed more so than the materials history side, which is lacking.

As there are gaps in the history and technology of acoustical materials, particularly with acoustical plaster, further research is needed. A list of areas that need more study are: the similarities and differences among the assortment of acoustical plaster recipes; the reasoning behind the combination of lightweight aggregates and foaming agents in acoustical plaster; how their
performance or deterioration relates to updates and improvements to acoustical products; precisely how acoustical materials age or deteriorate over time; and the connection between manufacturers of insulation materials, the mining industry, and the acoustics industry. Additionally, other areas that could be explored are: a more precise history and manufacture of each type of acoustical material; the types of paint used for decoration of acoustical materials; the usage of acoustical materials in residential spaces; and the locations of extant historic acoustical materials since these are topics that have not been covered in depth in any one book or source.

The development and technology of these early twentieth century materials can be further examined by looking into more archives. For instance, visits should be made to archives at other architecture schools or at physics and acoustic laboratories. In addition, contacting major acoustics corporations, like Celotex, Johns-Manville, National Gypsum, and United States Gypsum, may yield results. Perhaps local libraries of where acoustical materials manufacturers were/are based have resources available as well. The aforementioned sources may also provide samples of historic acoustical materials that can be tested and reverse engineered to figure out their composition. This would give a better understanding of what goes into the manufacturing of the material and how exactly their acoustic properties are produced.

The story of early twentieth century acoustical materials does not end here. With further research and access to more resources, this story can continue. Hopefully, knowledge of these materials will spread and posterity will remember and recognize their importance in history.

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Journal of the American Institute of Architects, December 1919.


Appendix A: Additional Images

Images Referenced in Chapter 2
Referenced in Chapter 2, footnote #65 – Advertisement on Johns-Manville Sound Control (Image courtesy of Columbia University in the City of New York Avery Architectural and Fine Arts Library)

Referenced in footnote #68 from Figure 1 | Present-day image of United States Court of Appeals, Denver, Colorado (Image courtesy of Tenth Circuit Court of Appeals, 2014, https://www.ca10.uscourts.gov/)
Referenced in footnote #74 from Figure 3 | Present-day image of Harvard Club, Boston, Massachusetts
Extra Images for Visual Reference
Images are all courtesy of Columbia University in the City of New York Avery Architectural and Fine Arts Library, unless otherwise noted

Acoustical felt (usually hidden behind membrane)
(Images courtesy of Johns-Manville Co.)

Present-day examples of acoustical felt:
(Images courtesy of Sandow Interior Design)
Acoustical fiber tiles and boards
(Images courtesy of Celotex Co.)

Some examples of Acousti-Celotex decoration:
Present-day examples:
Acoustical masonry tiles
(Images courtesy of Dorothy Krotzer)
Acoustical plaster
(Image courtesy of Columbia University in the City of New York Avery Architectural and Fine Arts Library)
Present-day examples:
(Images courtesy of IIS Interiors, Digo Products, and EverGreene)
Appendix B: Select Documents and Publications

APPROXIMATE COST OF ACOUSTICAL TREATMENTS

Cost applied per Square Yard.

Common Gypsum Plaster scratch and brown coat... $0.75 to $1.00
White finish coat.............................. $0.40 to $0.60
Akoustolith Plaster 1\(\frac{1}{2}\)" thick plus binder coat... 2.50 to 3.00
" " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " " 

The above prices vary according to the size, location and condition of the job. Some manufacturers will lower their prices to meet competition.
<table>
<thead>
<tr>
<th>Materials</th>
<th>AUGUSTOLITH PLASTER</th>
<th>SABINITE PLASTER</th>
<th>MACOUSTIC PLASTER</th>
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</thead>
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<td>Tested by</td>
<td>C. W. Swan- and Bureau of Standards</td>
<td>P. E. Sabine U.S.B.S.</td>
<td>U.S.B.S.</td>
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<td>Efficiency at C-1</td>
<td>32% - U.S.B.S.</td>
<td>22% - U.S.B.S.</td>
<td>22% - U.S.B.S.</td>
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<tr>
<td>Covering Capacity per ton ½&quot;</td>
<td>110 yds. Mfg. claim 100 yds.</td>
<td>50 yds. Mfg. claim 60 yds.</td>
<td>100 yds. to ton Mfg. claim</td>
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<tr>
<td>Cost per ton</td>
<td>$115 - $150</td>
<td>$85.00</td>
<td>$110.00</td>
</tr>
<tr>
<td>No. of coats</td>
<td>1 coat - ½&quot; or 1 coat - ¾&quot;</td>
<td>2 coats total ½&quot;</td>
<td>2 coats to get total ½&quot;</td>
</tr>
<tr>
<td>Treatment required following application</td>
<td>None</td>
<td>Cork floated</td>
<td>Stippled</td>
</tr>
<tr>
<td>Ingredients</td>
<td>Italian Pumice</td>
<td>Pumice &amp; Dolenite</td>
<td>Vegetable fibre &amp; a cement</td>
</tr>
<tr>
<td>Binder</td>
<td>Portland Cement</td>
<td>Gypsum</td>
<td>-------</td>
</tr>
<tr>
<td>Materials</td>
<td>Type BB Acousti</td>
<td>Celotex &quot;B&quot;</td>
<td>Masonite</td>
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<tr>
<td>-----------</td>
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<td>------------</td>
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<tr>
<td>Efficiency at C-4</td>
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<td>40%</td>
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<td>Sugar Cane</td>
<td>Wood Fibre</td>
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<td>Fire resisting</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Injured by moisture</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Cost per sq. yd. installed</td>
<td>$7.00</td>
<td>$5.75 - 6.00</td>
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<tr>
<td>Appearance of surface</td>
<td>Perforated</td>
<td>Perforated</td>
<td>Fibrous</td>
</tr>
<tr>
<td>Materials</td>
<td>Cork Acoustico</td>
<td>Acoustico</td>
<td>Halico</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Eff at C-4 in %</td>
<td>28%</td>
<td>3/8&quot; thick</td>
<td>3/8&quot;</td>
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<tr>
<td>Composition</td>
<td>Cork</td>
<td>Limestone</td>
<td>Same as</td>
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<tr>
<td></td>
<td></td>
<td>Keene's Cement</td>
<td>Acoustico</td>
</tr>
<tr>
<td>Fire Resisting?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Injured by Moisture?</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Appearance of Surface</td>
<td>Like Cork</td>
<td>Granular</td>
<td>Stippled</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Armstrong Cork Co.</td>
<td>Ohio Hydrate &amp; Supply Co.</td>
<td>Macheco Stockade Corp.</td>
</tr>
</tbody>
</table>
California Stucco Products Company

CALIFORNIA STUCCO PRODUCTS COMPANY
169 Waverly Street
CAMBRIDGE, MASS.

101 Park Avenue
NEW YORK, N. Y.

STUCOUSC—AN ACOUSTICAL PLASTER
For Economical Sound Absorption and Sound Control

Low Cost—Integral Colors—Architectural Adaptability
May be applied with trowel or cast to desired shape

Description
Stucco is unique among acoustical treatments. It is a high sound absorptive plaster which can readily be applied by the skilled artisan. It is composed of permanent materials cemented together to produce a fire-resistive insulative finish adaptable to all architectural conditions.

Stucco is generally finished with a steel trowel. With this finish, all particles of aggregate are completely embedded in the body of the plaster, making the surface comparatively smooth, sanitary and high light reflective. In the natural color it has a light reflection factor of 71%.

Stucco can also be floated, stippled, textured, antiqued or finished in other ways as desired.

Although it is produced in six standard colors, other colors can be produced to meet special requirements. Colors are integrally mixed at the factory and they do not fade.

To meet the demands of effective noise control we offer this attractive, economical and permanent plaster.

Application
Regular plasterers apply Stucco. It is mixed to the consistency of ordinary mortar and applied to a brown coat of gypsum, portland cement, or lime plaster. One plasterer will normally apply per hour from 8 to 12 sq. yds. of 2-coat Stucco finished ½ in. thick.

Painting
Water-mixed paints, sprayed on, are recommended. Test data of Stucco spray painted with five coats of water-mixed paint show a reduction of 25% of sound absorption. Painting instructions furnished on request.

Type A.C. for Casting
Stucco is for casting purposes; it sets rapidly and produces strong, sharp castings. It can be integrally colored or painted.

Service
Our Service Department will supply complete specifications on request, and a supervisor will be sent to each job to advise as to the preparation of the base coat and proper application of Stucco Acoustical Plaster.

Specifications for Stucco, Type A.D. Acoustical Plaster
Areas to receive acoustical plaster shall be given a scratch and brown coat in the ordinary manner. The surface of the brown coat shall be scored and scored or crossed scratched for bond and allowed to dry thoroughly before the application of the acoustical plaster.

Note: Where Stucco is subjected to high humidity or periodic wetting, no gypsum shall be used in base coats. Use plaster base coats consisting of equal parts by weight of portland cement and hydrated lime and four parts of sand.

Stucco Plaster shall be applied to the dry base coat, without sprinkling or otherwise reducing the suction, in coats, about ¾ in. thick, to a total thickness of Stucco of ¾ in. (or ¼ in. as desired). Note: A total thickness of less than ¼ in. is not recommended. The surface shall be finished as directed by the architect and all mixing and application of Stucco shall be done in accordance with the instructions of the California Stucco Products Company and under the direction of their representative.

SOUND ABSORPTION TEST DATA

Results of tests made by Bureau of Standards are listed below. All samples were applied to gypsum base coat plaster and steel trowel finished.

<table>
<thead>
<tr>
<th>Stucco Type</th>
<th>Thickness</th>
<th>Coefficient of Sound Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>1/8</td>
<td>12</td>
</tr>
<tr>
<td>A10</td>
<td>5/60</td>
<td>18</td>
</tr>
</tbody>
</table>

A Few Stucco Jobs and Their Architects
Benjamin Franklin High School, New York, N. Y., Mr. Kibbey
U. S. Naval Academy Chapel, Annapolis, Md., Mr. Lee
Hayden Memorial, Boston University
City & Foreman
Circle Theatre, Brattleboro, Vt.
Chowen National Bank, New York, N. Y.
National Geographic, Washington, D. C.
Nathan W. Cofrin, Boston, Mass.
State Hospital, Denver, Park, L. I., N. Y.
Wm. Happaid
Borden Y. M. C. A.
Beverly Hospital, Beverly, Mass.
Pawtucket High School, Pawtucket & Albion
John F. Valentine

Other Products
Exterior Concrete Stucco, Interior Line, Colored Plaster, Colored Floor Finish, Cement and other spaces.
SPECIFICATION

Areas to receive Stucoustic plaster shall be given a scratch and brown coat in the ordinary manner. The surface of the brown coat shall be lightly scored or cross scratched for bond with the Stucoustic Plaster. Plaster screeds shall have been removed and the brown coat allowed to dry thoroughly before the application of the Stucoustic Plaster.

Stucoustic Plaster shall be applied to the dry brown coat without sprinkling or otherwise reducing the suction, in a series of coats about \( \frac{1}{4}'' \) to \( \frac{3}{4}'' \) thick. The second coat not exceeding \( \frac{3}{4}'' \) in thickness, may be applied as soon as the first coat has taken up, usually in about one hour. (Where the total thickness specified exceeds \( \frac{3}{4}'' \) the additional thickness shall be applied not sooner than the day following the application of the first two coats.)

NOTE—For a coarse surface specify finish coat shall be Stucoustic Plaster “XB”. For a fine grained surface specify finish coat shall be Stucoustic Plaster “XC”.

NOTE—Where Stucoustic Plaster is subjected to an atmosphere of high humidity or continual periodic wetting, no gypsum plaster shall be used in base coats. Use plaster base coats consisting of equal weights of Portland cement and hydrated lime and two parts clean sharp sand. Mix shall be one sack Portland cement, two sacks hydrated lime and two cubic feet of sand.

MIXING AND APPLICATION OF STUCOUSTIC PLASTER

Only a clean tight box shall be used. Mix too wet to apply and allow to stand for one hour. Add dry Stucoustic Plaster to stiffen to consistency of good mortar. In cold weather when mixing water is cold, the use of heated water will greatly improve the workability of Stucoustic Plaster.

This material should not be soaked over night but may be retempered if necessary.

APPLICATION

Brown coat must be dry before beginning application of Stucoustic Plaster. Do not wet the brown coat to reduce the suction.

Apply about \( \frac{3}{4}'' \) thickness of Stucoustic Plaster leaving the surface as it comes from the trowel. Allow at least one hour to take up, then double with coat not exceeding \( \frac{3}{4}'' \) in thickness. If a greater thickness than \( \frac{3}{8}'' \) is required, the additional thickness may be applied not less than 12 hours after application of the \( \frac{3}{4}'' \) thickness.

FINISH FOR STUCOUSTIC XC

Darby surface with metal darby immediately after application using no water for this operation.

FINISH FOR STUCOUSTIC XB

Lightly float with cork float without the use of additional water to remove darby marks.

Lightly trowel to embed any particles loosened by darby or float. Never trowel while surface shows any free water.

In all operations avoid compacting the plaster. When finished the surface should show a multitude of fine pores extending into the body of the Stucoustic Plaster.

COUSTILAC

Coustilac shall be applied with brush or spray after Stucoustic Plaster has thoroughly dried. Care must be taken not to close the surface pores or acoustical efficiency will be reduced. Detailed information will be furnished.
Type "D" Acousti-Celotex on entire main ceiling area.
Type "C" Acousti-Celotex in lunettes and on choir ceiling.

The original in this digital image is housed in:
Avery Classics, Avery Library, Columbia University
This copy is to be used for research and educational purposes only.
Not for publication or further copying.
ACOUSTI-CELOTEX
used in buildings of all types
for acoustical and sound quieting purposes

A PRODUCT OF

THE CELOTEX COMPANY
645 North Michigan Avenue
CHICAGO

MILLS: NEW ORLEANS, LOUISIANA

BRANCH SALES OFFICES:
(See telephone books for addresses)

Boston
Cleveland
Dallas
Denver

Detroit
Jacksonville
Kansas City
London (Eng.)

Los Angeles
Miami
Milwaukee
Minneapolis
New Orleans

New York
Philadelphia
Portland, Ore.
Salt Lake City
San Francisco
Seattle
St. Louis
St. Paul

Canadian Representatives:
Montreal
Toronto

Alexander Murray & Company, Limited
Halifax
Winnipeg
Vancouver

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Form 327-31 M. 10-15 Printed in U. S. A.
By Wm. G. Knicker & Co., Chicago
Partial list of some of the more important Acousti-Celotex installations

<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th>Architect</th>
</tr>
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<tbody>
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<td>Milwaukee Auditorium</td>
<td>Milwaukee, Wisconsin</td>
<td>Judell &amp; Bogner</td>
</tr>
<tr>
<td>Municipal Auditorium</td>
<td>St. Joseph, Missouri</td>
<td>Eckel &amp; Aldrich</td>
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<td>Dallas, Texas</td>
<td>Lang &amp; Witchell</td>
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<td>W. E. Robertson</td>
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<td>Providence, R. I.</td>
<td>Stevens &amp; Lee</td>
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<td>Stevens &amp; Lee</td>
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<td>A. T. &amp; S. F. Hospital</td>
<td>Albuquerque, N. M.</td>
<td>Gay A. Garlander</td>
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<td>Royal Victoria Memorial Maternity Hospital</td>
<td>Montreal, Quebec</td>
<td>Stevens &amp; Lee</td>
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<td>Bradenton Bank &amp; Trust Company</td>
<td>Bradenton, Florida</td>
<td>Georgia Show Case Co.</td>
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<td>Kansas City, Missouri</td>
<td>Wight &amp; Wight</td>
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<td>Kansas City, Missouri</td>
<td>McKeeble &amp; Trask</td>
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<td>Sante Fe Eng. Dept.</td>
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<td>Sound Testing Laboratory — Jefferson Electric Company</td>
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<td>Houck &amp; Smirner</td>
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<td>Jefferson Elec. Co.</td>
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<td>O’Connell &amp; Shaw</td>
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<td>Albert Kahn, Inc.</td>
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<td>Loranz Schmidt &amp; Co.</td>
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<td>Richmond, Virginia</td>
<td>G. O. Foil &amp; G. Amsubb</td>
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<td>Council Bluffs, Idaho</td>
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<td>Geo. Barten Co.</td>
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<td>Company Eng. Dept.</td>
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<td>Mountjoy &amp; Frewen</td>
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<td>Chicago, Illinois</td>
<td>Anderson &amp; Spooner</td>
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<td>St. Peter’s Church</td>
<td>Kansas City, Missouri</td>
<td>Joseph Finger</td>
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<tr>
<td>Rodfield Temple</td>
<td>Detroit, Michigan</td>
<td>John Latenser &amp; Son</td>
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<tr>
<td>Sixth Church of Christ, Scientist</td>
<td>Honolulu, Hawaiian Islands</td>
<td>A. Epstein</td>
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<tr>
<td>First Presbyterian Church</td>
<td>Chicago, Illinois</td>
<td>Chas. A. Smith</td>
</tr>
<tr>
<td>Central Union Church</td>
<td>Kansas City, Missouri</td>
<td>Smith, Hinchant &amp; Gryle</td>
</tr>
<tr>
<td>Moody Church</td>
<td>Detroit, Michigan</td>
<td>Gram &amp; Ferguson</td>
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<tr>
<td>Temple B’nai Jeshurun</td>
<td>Honolulu, Hawaiian Islands</td>
<td>Fugard &amp; Knapp</td>
</tr>
<tr>
<td>Lowell District Court House</td>
<td>Chicago, Illinois</td>
<td>Charles R. Greco</td>
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<tr>
<td>Scottish Rite Cathedral</td>
<td>Cleveland, Ohio</td>
<td>Chas. K. Grove</td>
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<tr>
<td>Scottish Rite Cathedral</td>
<td>Lowell, Massachusetts</td>
<td>Asmus &amp; Clark</td>
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<tr>
<td>Jewett Radio &amp; Photograpic Studio—Book Cadillac Hotel</td>
<td>Nashville, Tennessee</td>
<td>Wm. B. Ittner Co. Inc.</td>
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<td>Newport High School</td>
<td>St. Louis, Missouri</td>
<td>Smith, Hinchant &amp; Gryle</td>
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<tr>
<td>Eiel High School</td>
<td>Detroit, Michigan</td>
<td>Board of Education</td>
</tr>
<tr>
<td>U. S. National Bank</td>
<td>St. Louis, Missouri</td>
<td>Geo. A. Williamson</td>
</tr>
<tr>
<td>Municipal Auditorium</td>
<td>Denver, Colorado</td>
<td>A. E. Doyle</td>
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<tr>
<td></td>
<td>Portland, Oregon</td>
<td>A. B. &amp; R. M. Ayers— G. Willis—E. Jackson</td>
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</table>

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ARCHITECTURAL ACOUSTICS

THE architect no longer need approach the design of an important building containing an Auditorium with a feeling of uncertainty about the hearing conditions in the finished structure; he need not await completion to determine whether the acoustics are good or bad; he need not make sacrifices in proportion in order to copy some existing hall known to have good qualities; he need have no objectionable restraint in interior decoration. The science of acoustical analysis and design, and the art of manufacture and application of sound absorbing materials, as now developed, make it entirely practicable to design and specify acoustical treatment with assurance of obtaining definitely pre-determined and measurable results.

A Brief Statement of the Theory of Sound

Sound vibrations are transmitted from the point of origin, through the air or other media. These vibrations progress in concentric spheres, with the intensity diminishing until the sound becomes inaudible. This condition is approximated in the open air, but when encompassed in a room the vibrations quickly strike the walls, ceiling and floor.

When a sound vibration impinges on a surface, a part of the energy is reflected and a part is absorbed. The reflected portion reverberates from surface to surface, losing a part of its energy with each impact until its intensity is below the limit of audibility. The number of contacts necessary to reduce it to this stage depends on the percentage absorbed at each impact. Sound travels in air, at the average rate of 1100 feet per second regardless of its intensity and volume. With a given percentage of absorption, the length of time that the energy will persist depends on the average distance between the reflecting surfaces.

From the foregoing, it follows that the absorption coefficients of the surfaces and the dimensions of the room are important factors in the problem. Reverberation will cease more quickly with highly absorbent surfaces, and more quickly in small than in large rooms.

What happens to one element of a sound sphere applies also to every other element and to each succeeding emanation of sound. A sound may persist for 5 to 15 seconds. Considering each spoken syllable as a separate sound and the speed of diction from two to five syllables per second, it is evident that there may be from 10 to 75 sounds in a room at one instant. This overlapping or reverberation is the primary condition that must be controlled to permit the original sounds to reach the ear distinctly. This is accomplished by using sound absorbing surfaces of such materials and in such quantities as required by each specific case.

Although the fundamental principles here outlined have been established for a long time, it is only during recent years that constants have been determined and formulas developed for the practical solution of the many problems in architectural acoustics. The data now available enable one to compute the reverberation period for any given set of conditions as expressed by plans or by the actual structure. Study of existing rooms having satisfactory hearing conditions has led to definite values of the reverberation periods that are desirable for audition. Thus it has become practicable to determine accurately, the quality and amount of treatment required.

The determination of the number of absorbing units required does not constitute the entire solution of the problem. There must be taken into account, curved surfaces which tend to concentrate sound; stage opening and stage spaces with their scenery and other equipment; spaces under balconies, which have some characteristics of separate rooms. It is also necessary to consider co-ordination with interior decorations; preservation of suitable resonance; obstructions in path of sound from speaker to auditor; influence of absorption of sound by audience and furnishings; and possibly other factors. Some of these items involve computations and others are determined by the good judgment developed from experience.

THE CELOTEX COMPANY, CHICAGO

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Sound Absorbing Materials

The scientific development of acoustical analysis has outstripped the art of manufacture and application of materials suitable for this work. The materials of construction commonly used for the surfaces of interiors, consisting of plaster, stone, concrete and wood have very small absorbing power. It is only within the past few years that special materials have been offered for this purpose. Three classes of special materials have practical value: (a) earthy materials in the form of tiles and plasters, which have only sufficient value to make them available in very few situations; (b) Soft felts made of animal hair or other materials, which have higher absorption co-efficients than earthy materials with varying merits as to practical utility; (c) Acousti-Celotex.

Acousti-Celotex

The best sound absorbing material for Architectural work is Acousti-Celotex, a board made by felting the fibres of sugar cane; the same basic material as Celotex Insulating Lumber, which is revolutionizing and greatly augmenting the thermal insulation of buildings. Its natural value as a sound absorbert has been greatly increased by special treatment, developing a co-efficient up to 55%. The remarkable increase above the normal absorption is obtained by drilling holes into the Celotex, thus adding about 150% to the absorbing area. This drilling is done with special machines carrying 100 drills, ¾ inch in diameter in an area 6 inches square and 400 drills in an area 12 inches square.

Type A is ¾ inch thick, with holes drilled to a depth of ¾ inch. It is applied with the plain side exposed to the sound and is used only in the few cases where the scheme of interior decoration precludes the use of Type B.

Type B is also ¾ inch thick and is installed with the drilled surface exposed to the sound.

Type C is made of single thickness Celotex with holes drilled through. It requires a hollow space back of it not less than ½ inch.

Type D is specially prepared Celotex Standard Building Board cut to proper sizes for use in connection with other types of Acousti-Celotex.

The selection of the type to be used is a part of the acoustical analysis and is influenced by the proposed decorative treatment and the structural conditions.

Acousti-Celotex is made in slab or tile form in sizes 6" x 12" and multiples up to 12" x 24". The preferred sizes are 12" x 12" and 6" x 12".

Acousti-Celotex is applied by nailing to wood grounds or wood furring strips, or by cementing to a suitable base of plaster or masonry, or by nailing with square cut nails to gypsum plaster surface. (See Acousti-Celotex Specifications, File A. I. A. 39 b.)

Thousands of existing buildings are unsatisfactory in their acoustic properties. They can be treated as readily as new ones.

Acousti-Celotex can be applied to any kind of wall and ceiling surface without disturbing the interior construction. Original or existing decorative effects can be re-produced on the Acousti-Celotex surface.

It is important to emphasize that any type or size of interior with faulty or unsatisfactory acoustics can be effectively corrected with Acousti-Celotex. The Celotex Company solves acoustical problems and provides instruction for proper procedure.

There are two classes of rooms which require acoustical treatment, viz:

(a) Where people are assembled to hear music or speaking.

The best possible hearing conditions are desired in this class. To have these conditions the reverberation must be reduced to the proper period, but the absorbing material must not be of such character as to make the room “flat” or “dead.” Resonance must be preserved and there must be retained enough reflected energy to carry the sounds to the full limits of the room. In this class are: Auditoriums, Churches, Theatres, School Rooms, Music Rooms, Court Rooms, Lodge Halls, Railway Stations, etc.

(b) Where people, at work, requiring mental application, are subjected to disturbing noises. The general principles involved are the same for both classes, but the extent of the treatment differs.

Where quieting is the motive, the treatment should eliminate all reflected sound as fully as possible, especially the higher frequencies found in office noises. In this class are: Banks, Computing rooms, Typing Rooms, Restaurants, Billiard Halls, Printing Press Rooms, Composing Rooms, Offices, Hospitals, Radio Broadcasting Studios, etc.

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Benefits of Acoustical Treatment

That perfect audition is desirable is self-evident. Fair, mediocre, even poor audition has been tolerated because there seemed to be no dependable cure. Good hearing conditions can now be assured and tolerance of bad conditions is inexcusable. A good Auditorium now attracts attention, which means that it attracts business. As good ones become available, the poor will suffer loss of patronage. Certainly the owner of a building, old or new, should have the most advanced treatment in acoustical correction as well as in other features of his building, to protect his property from becoming obsolete.

In the field of soundquieting the economic aspect is equally or even more important. Efficiency and accuracy cannot always be measured in money, but everyone knows that it has substantial value, and everyone knows that high efficiency cannot be attained in a noisy room. To this must be added the health of the workers, for many nervous breakdowns have been caused by noise.

Advantages of Acousti-Celotex

Acousti-Celotex is the most practicable and available material for acoustical control. It is efficient and scientifically correct as a sound absorber; easy to apply; valuable as a decorative material and suitable as a base for color work. Acousti-Celotex is permanent and may be specified in amount and location indicated by proper analysis of each variable, so as to produce results that have been computed in advance and which can be measured after installation. It will retain a proper degree of resonance and purity of tone as proved by an ample number of successful installations.

The cost of an Acousti-Celotex installation is reasonable for the results attained. Acousti-Celotex is without a peer in its field.

In making analyses and specifications for acoustical treatment The Celotex Company uses the formulas and data developed by the late Prof. Wallace Sabine of Harvard University, Prof. F. R. Watson of the University of Illinois, as well as from texts by English and German authorities. It uses the absorption co-efficients of Acousti-Celotex determined by Prof. Watson. With a corps of trained men, equipped with the most complete compilation of scientific data, the Acoustical Division of The Celotex Company is the best source for analyses, specifications, information and advice in Architectural Acoustics.

To assure satisfactory results where its material is used and to insure the owner against error and the cost of treating excessive areas, the Company offers this service without charge. Architects and Owners are invited to submit their inquiries. Complete plans and specifications of the building are desired if available. For existing buildings, The Celotex Company will cooperate in getting the necessary data.

The Celotex Company prepares analyses and specifications gratis for every inquiry submitted. It then sells the proper amount of Acousti-Celotex with the assurance that certain stated results will be obtained. Approved Acousti-Celotex Contractors are located throughout the country. Responsible building contractors are competent to make installations of Acousti-Celotex.

Quotations can be obtained from either of the above sources, or direct from The Celotex Company and its branch offices.

DECORATING ACOUSTIC CELOTEX

One of the most striking merits of Acousti-Celotex is its adaptability to decorative treatment:

(a) It is attractive in its natural color.
(b) Oil paints can be successfully used on Acousti-Celotex. Types B and C without impairing the acoustical properties.
(c) Color in the form of stains, dyes, and water colors may be applied to all types of Acousti-Celotex by brushing or spraying over the entire surface, or by stencilling patterns on the natural surface.

The architectural design of the ceiling and walls need seldom be modified to accommodate Acousti-Celotex as it can be fitted to panels of any shape and can be made to conform to areas of single or double curvature. Its use does not interfere with cornices, ceiling beams, pilasters, skylights, ventilators or other features. The areas used can be varied slightly, when necessary, to conform to the areas available. The architect may generally elect whether the treatment shall be on ceilings or side walls, or both. He may select the size of tiles and the patterns in which they shall be laid.

The color plates as shown in this book are from working drawings of actual installations of decorated Acousti-Celotex and point to the unlimited possibilities of color design on this material. It should also be mentioned here that the decorating by means of stencils as illustrated is likewise applicable to Celotex Standard Building Board.
THE Great Chicago Methodist Temple in the heart of the "loop" district, built as a monument to religion amid the strife and turmoil of business.

The Temple was designed by Holabird & Roche, Chicago Architects, and the Acousti-Celotex treatment as shown below, beautifully decorated by Alexander Rindskopf, also of Chicago.

Interior of Chicago Methodist Temple. Architects Holabird & Roche, Chicago, Ill. Acousti-Celotex Type D, decorated, in all panels on main ceiling and ceiling under balcony.

Decoration on Celotex used at the display booth of The Celotex Company, at the Architectural and Allied Arts Exposition, Grand Central Palace, New York City, faithfully reproducing in color and form, motifs from the Davenport Palace in Florence, in early Renaissance.
OUR Universities of today are demanding perfect acoustics in their assembly auditoriums and chapels. Having laboratories, departments of engineering and physics for research investigations of different acoustical materials, the adoption of Acousti-Celotex carries the endorsement of competent scientific authority.

BAD acoustical conditions in the meeting room of the St. Louis Board of Public Service made satisfactory meetings impossible. E. R. Kinsey, president of the Board, after analysis by The Celotex Company, contracted for Acousti-Celotex on a basis of "no cure — no pay."

"Lo, one could hear," said the St. Louis Post Dispatch after the first meeting under the Acousti-Celotex conditions.
ACOUSTI-CELOTEX reinforces the carrying capacity of the voice and instrumental music in a large interior. This auditorium is almost four hundred feet long and seats 12,800 persons. John Philip Sousa pronounced it the most wonderful auditorium in the world for band music. Jeritza marvelled at the tone quality of her voice when singing there. Billy Sunday, who possesses a voice of less volume than the average public speaker, was heard clearly and distinctly even from the farthest seats.

The press room of the Milwaukee Journal is scientifically treated with Acousti-Celotex, the super noise-destroyer of the age. The excessive crash and roar of the press room is absorbed.

With the relief from nerve-strain, pressroom employees benefit greatly in health and efficiency.
FAULTY acoustics actually persecute the leader of a congregation. Inspirational freedom, certainty of delivery, sympathetic response proceeding from good voice intonation and inflection; forceful thought sequence—all are denied the speaker.

Acousti-Celotex clears the interior of a church from sound traffic and disperses the jam of echo and reverberation—the road for perfect voice delivery is unobstructed. Speaker and music are heard without effort or strain.

The mental workshop of a newspaper operates under the terrific pressure of time, during the few hours allotted each day to its gigantic task. Nature provided us with a hearing sense that is not disturbed by incidental or original sounds, but which leaves us helpless when exposed to accumulated sounds in an enclosure.

Acousti-Celotex prevents noise distraction and accumulation and also softens the original sound. The working hours end refreshingly without undue mental and physical fatigue.
LODGES and fraternal societies conduct services that are often religious in character. Impressive quiet, dignity of surroundings and forcefulness in ritual are made possible by the proper use of Acousti-Celotex.

The interior pictured here includes all of these essentials and has been widely commented upon as an unusually successful meeting hall.

Showing Acousti-Celotex Type A Ashlar pattern in natural finish on walls of Scottish Rite Cathedral, St. Louis, Mo. Acousti-Celotex Type B also on all ceiling panels. Wm. B. Irwin Co., Inc., Architects, St. Louis, Mo.

This interior has a full correction so that conditions are ideal for rehearsals, practice hours, study purposes, and overflow class room use, besides providing perfect hearing qualities with any number of seats occupied.

Acousti-Celotex is used in its natural finish, and being of Type B, it can be attractively and inexpensively decorated at any time with any kind of paint or color without disturbing its acoustical value.

Acousti-Celotex Type B on ceiling of the Auditorium of North Side High School, Memphis, Tenn., Charles O. Pfeil and George Amsden, Architects, Memphis, Tenn.
THE disturbing and clanking noise of office and bookkeeping machinery is effectively destroyed by the use of Acousti-Celotex. Office noise injures the nervous and mental state of the clerical force so that quieting treatments for offices are of major concern to executives.

Particularly pleasing and helpful is the decorative design in warm and glowing colors, cheerfully contrasting the coldness and lack of suggestive welcome in the bank of yesterday. Acousti-Celotex provides a texture inspiring freedom in color design.


WHO would think that an acoustical or sound decaying material could be effective enough to satisfactorily prevent the accumulation of outside noises after they had entered an office? Acousti-Celotex, Type B, used on the ceiling, successfully solved this problem for Mr. Healy. It has the added value of adaptability to decoration as shown below.

Private Office of Marquette A. Healy, President, Lyon & Healy, Chicago, Illinois. Acousti-Celotex Type B decorated on ceiling, as shown below.

After six months occupancy of the room shown above, Mr. Healy writes:

"It has, I believe, eliminated the noise fully half, and even when the windows are open and the racket from the elevated trains is at its worst, this room is a great deal quieter than the adjoining rooms whose ceilings are of the regular plaster type.

"The absence of noise so obtained makes conversation much easier and pleasanter, and I believe one is less fatigued at the end of a day's work."

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ACOUSTI-CELOTEX was awarded a Silver Trophy at the Third Annual Radio Convention at Chicago in 1924 and similarly honored at the New York Radio Show of 1925. This unique and exclusive testimonial points to the value of this material to Science. Acousti-Celotex absorbs the residual and overlapping sound waves effectively and at the same time maintains full resonance and brilliancy; all without reduction of tone purity or change of tone quality.

Above: Detail of ceiling decoration.

At left: Detail of wall decoration.

At right: Detail of mural on wall.
This interior presents the first example in making possible the successful broadcasting of pipe organ music.

In this moderately sized room, Acousti-Celotex has contributed clearness of expression, the organ being played as in a church or large auditorium, its filtered tones going out on the air clearly and distinctly without echo, blasting or other disturbances.

The ceiling of Acousti-Celotex in Type B with closely abutted joints carries very gracefully the stencil decorative design in Japan colors, here shown.

The Adam expression was carried out with the utmost freedom, the texture of the Acousti-Celotex providing an unusually effective field. Celotex also used on side walls.
ARTISTS who perform in Acousti-Celotex Studios all testify to a remarkable clearness of voice and intonation, encouraging them to do their best work.

In successful radio broadcasting studios, the acoustical requirements are more severe than in any other type of room. Sounds of all pitches and variations of intensity must be preserved and transmitted without distortion. Complex problems of this character are solved by the use of Acousti-Celotex.

This ceiling design in the studio of Nelson Bros., shown above, is characteristic of Florence of the XIV Century and is true to the original model both in color and in drawing.

Radio Broadcasting Studio of Nelson Bros., Bond & Mortgage Company, Chicago, Ill. Acousti-Celotex Type B decorated, on ceiling, and Acousti-Celotex Type D in Ashlar pattern, on walls, in natural finish. Designed by the Service Department, The Celotex Company.
In this charming Country Club the application of Acousti-Celotex Type D, to the walls and ceilings has contributed three important benefits:

(a) Thorough insulation against the heat of summer and the chill of winter; providing all-year comfort.

(b) Acoustics so perfect that the club is sought for musicals, lectures and other entertainments in preference to theaters and other meeting rooms in the community.

(c) An unusually pleasing decorative effect.

This XIV Century decoration of Early Renaissance is reproduced on the Celotex walls of the Bethany Girls Home in Chicago.

These designs and color schemes show the unlimited possibilities of decorating Celotex and Acousti-Celotex in any manner desired.
THE CELOTEX COMPANY

CHICAGO, ILLINOIS

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Products of The Celotex Company

CELOTEX STANDARD BUILDING BOARD

Thickness approximately 7/16"; average weight 60 lbs. per 100 sq. ft.; width 4 ft.; lengths 8 to 12 ft.
A felted and waterproofed cane fibre board with heat insulating value of 0.33 B. t. u. per hour per sq. ft. per deg. Fahr. per inch thickness. Its strength in wall sections is greater than horizontal pine sheathing. It has a higher sound insulation value than standard deadening felts.

Principal Uses
A. Sheathing (and insulation) for frame, stucco and brick veneer buildings, replacing wood sheathing.
B. Under plaster (and as insulation) replacing lath or plaster board.
C. Floor and wall sound deadener.
D. Interior and exterior wall finish. Can be painted or stained or left natural. (See specifications—"Celotex Standard Building Board.” A, I. A, File 37 a 1.)

CELOTEX INDUSTRIAL BOARD

Thickness approximately 1/8"; average weight 58 lbs. per 100 sq. ft.; width 3 ft.; length 6 ft.
Industrial Board has insulating value equal to that of Standard Building Board but less tensile strength, hence should not be used as replacement of wood sheathing; under plaster; interior or exterior finish, for which purposes Standard Building Board is especially adapted.

Principal Uses
Commercial roof insulation for industrial plants, for fuel economy and the prevention of condensation on ceilings.
(See specifications—"Celotex Industrial Board.” A, I. A, File 37 a 1.)

CELOTEX INSULATION

Thickness 3/4"; average weight 50 lbs. per 100 sq. ft. Manufactured in special sizes to comply with the requirements of railroad car builders and other manufacturers.

Principal Uses
A. Railroad Refrigerator Car Insulation.
B. Steel Car Insulation.
C. Domestic Refrigerators.
D. Ice Storage Houses.
Address company for literature and information.

ACOUSTI-CELOTEX

Especially manufactured for acoustical correction, including treatments for auditoriums, quieting and sound insulation.
(See specifications—“Acoasti-Celotex.” A, I. A, File 39 b.)
SPECIFICATIONS and DETAILS for the APPLICATION and DECORATION of ACOUSTIC-CELOTEX for ACOUSTICAL TREATMENT

A Product of THE CELOTEX COMPANY
645 NORTH MICHIGAN AVE., CHICAGO, ILLINOIS
MILLS NEW ORLEANS
Types and Sizes
of ACOUSTI-CELOTEX

**Types and Coefficients**

ACOUSTI-CELOTEX is made of Celotex Standard Building Board perforated with a large number of drilled holes to increase its sound absorbing capacity.

The sound absorbing values of ACOUSTI-CELOTEX are based upon the standard frequency of 512 vibrations per second, a tone one octave above middle C. The authority for these values is Professor F. R. Watson of the University of Illinois.

The figures shown indicate the portion of sound energy absorbed at each impact of a sound wave. One square foot of open window is considered as having total absorption and is given a value of one sound absorbing unit. Type B ACOUSTI-CELOTEX absorbs 55 per cent of the sound energy which strikes it and hence has a value of .55 sound absorbing units per square foot or a coefficient of .55.

### Types

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<th>Type</th>
<th>Description</th>
<th>Sound Absorbing Units Per Sq. Ft.</th>
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<tr>
<td>A</td>
<td>ACOUSTI-CELOTEX 3/8&quot; thick with 400 perforations per square foot, each perforation 3/4&quot; in diameter and 3/8&quot; deep, applied with perforations concealed</td>
<td>.37</td>
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<tr>
<td>B</td>
<td>same as Type A, applied with perforations exposed</td>
<td>.55</td>
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<tr>
<td>BB</td>
<td>ACOUSTI-CELOTEX 13/32&quot; thick with 400 perforations per square foot, each perforation 3/4&quot; in diameter and 13/32&quot; deep, applied with perforations exposed</td>
<td>.70</td>
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<td>C</td>
<td>ACOUSTI-CELOTEX 5/16&quot; thick with perforations extending from face to back</td>
<td>.40</td>
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<tr>
<td>D</td>
<td>ACOUSTI-CELOTEX 5/8&quot; thick without perforations</td>
<td>.25</td>
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### Sizes

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<td>208</td>
<td>12&quot; x 12&quot;</td>
<td>no stiles thru center</td>
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<td></td>
<td>222</td>
<td>12&quot; x 12&quot;</td>
<td>with square edges, stiles thru center</td>
</tr>
<tr>
<td></td>
<td>224</td>
<td>6&quot; x 12&quot;</td>
<td>with square edges, no stiles thru center</td>
</tr>
<tr>
<td></td>
<td>228</td>
<td>12&quot; x 12&quot;</td>
<td>stiles thru center</td>
</tr>
<tr>
<td></td>
<td>206</td>
<td>12&quot; x 12&quot;</td>
<td>with beveled edges and 2 V-cuts forming four 6&quot; x 6&quot; units</td>
</tr>
<tr>
<td></td>
<td>408</td>
<td>12&quot; x 12&quot;</td>
<td>beveled, no stiles thru center</td>
</tr>
<tr>
<td></td>
<td>428</td>
<td>12&quot; x 12&quot;</td>
<td>not beveled, no stiles thru center</td>
</tr>
<tr>
<td></td>
<td>302</td>
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<td>with four beveled edges, stiles thru center</td>
</tr>
<tr>
<td></td>
<td>308</td>
<td>12&quot; x 12&quot;</td>
<td>without four beveled edges, no stiles thru center</td>
</tr>
<tr>
<td></td>
<td>322</td>
<td>12&quot; x 12&quot;</td>
<td>with square edges, stiles thru center</td>
</tr>
<tr>
<td></td>
<td>328</td>
<td>12&quot; x 12&quot;</td>
<td>with square edges, no stiles thru center</td>
</tr>
</tbody>
</table>

**See ACOUSTI-CELOTEX Detail Sheet, Page 4 for illustrations of types.**
Specifications for the Application of ACOUSTI-CELOTEX

1. Nailing to Wood Strips

Apply 1" x 2" or 1" x 3" wood furring strips spaced 12 inches on centers, or otherwise in accordance with the requirements of the design. The details on Pages 6 and 7 show methods of applying the strips to various types of construction.

In concrete or other masonry construction, it is usually found cheaper to place wood grounds 3 feet on centers, or as the construction demands, and then nail strips across these 12 inches on centers. On new work, place chips or grounds during construction. On old work, use toggle or expansion bolts or plugs.

Nail the ACOUSTI-CELOTEX slabs directly to the wood furring strips. With Type C and Type D ACOUSTI-CELOTEX on jobs where the nail heads must not show, use 4d finish nails and drive them into the bevel of the slabs at an angle. For a more substantial job, use a 3½" No. 17 flat head wire brad. The head is so small it can hardly be detected at a little distance. On a high ceiling use a 4d galvanized common shingle nail.

Type A ACOUSTI-CELOTEX is used mostly on walls and low ceilings where nail heads must be concealed. Use 6d finish nails and drive them into the bevel at an angle.

Type B ACOUSTI-CELOTEX can be applied with 6d finish nails, the same as Type A. The holes in the four corners of the 12" x 12" Type B slab are bored only half way thru. For a good job, drive 6d galvanized common nails into these corner holes and sink them with a nail set.

Type BB ACOUSTI-CELOTEX is usually used on high ceilings. Nail to wood strips with a 7d. box nail.

2. Nailing to Wood Ceiling

Many churches and large auditoriums have plank roofs with the bottom side of the planks exposed in the room below. In such cases, nail the ACOUSTI-CELOTEX directly to the planks. This provides a good finished surface and roof insulation in addition to acoustical treatment.

3. Nailing to Plaster

In nailing ACOUSTI-CELOTEX directly to plaster, use the old fashioned wedge shaped cut nails instead of wire nails. Their tapered shape makes them hold tight like a wood plug in a brick wall.

For Type C and Type D ACOUSTI-CELOTEX, use a 1" cut finish nail. For Type A and Type B use a 1½" nail. Use six nails for each 12" x 12" tile and drive them into the bevel at a 45 degree angle toward the center. Driving the nails at an angle furnishes an additional grip with the plaster surface. The length of the nails is quite important, especially if the plaster is on tile or brick. If the nails go thru the plaster and strike the hard backing, they will chip off the plaster and lose their hold.

CAUTION. This method of application should not be attempted unless the plaster is hard and solid and should never be used on lime plaster. A test of the plaster should be made by nailing up a few slabs to see how they hold before going ahead with the installation.

4. Cementing to Plaster

On domes and other surfaces of double curvature, 6" x 12" ACOUSTI-CELOTEX tile are usually cemented in a Herringbone Pattern to a rough plaster backing. Cementing is usually found more costly than other methods of application and requires more skill to produce a good job.

The cement now being used is a special casein compound made according to The Celotex Company's formula. It comes in powder form and only needs to be mixed with water to be ready for use. About one pound of cement is required for each square foot of ACOUSTI-CELOTEX.

5. Fastening to Special Suspended Ceiling

Most auditoriums have suspended ceilings and on new work the ceiling construction can be adapted to the application of ACOUSTI-CELOTEX with a saving in cost. The detail at top of Page 7 shows the construction.

Hang the 9" channels 3 feet on centers from the trusses. Wire 3/4" channels directly on centers to these, and wire metal lath to the 3/4" channels. Place 1" x 2" wood strips 12 inches on centers against the metal lath and wire them fast to each 3/4" channel. Put a rough coat of plaster on the metal lath between the wood strips bringing it up flush with the face of the strips. Nail the ACOUSTI-CELOTEX to the wood strips with nails as given under Specification No. 1.

See ACOUSTI-CELOTEX Detail Sheets, Pages 6 and 7, Showing Application
Expansion Bolts or Sleeper Clips - 36° O.C.

Concrete Ceiling

Concrete Joist Ceiling

Wood Joist Ceiling

Suspended Metal Lath & Plaster Ceiling

Application of Acousti-Celotex on Ceilings

Scale 3' = 1'-0"
Suspended Metal Lath & Plaster Ceiling
Special Construction

Application of Acousti-Celotex on Walls

Scale 3' = 1'-0"
Specifications for the Painting and Decoration of ACOUSTI-CELOTEX

The surface texture of ACOUSTI-CELOTEX is beautiful and interesting and, when relieved by over patterns in colors with natural ACOUSTI-CELOTEX as a background, produces many remarkable effects.

Stencil colors and dyes as mentioned below do not appreciably affect the acoustical value of any of the types of ACOUSTI-CELOTEX.

Paints of heavy body, such as are used in producing all-over tints, form a hard coating which reduces the acoustical value of Type A and Type D ACOUSTI-CELOTEX but does not affect Type B, Type BB or Type C.

**Stenciling ACOUSTI-CELOTEX**

Most of the attractive decoration of ACOUSTI-CELOTEX is accomplished by stenciling. For this work it is best to use Japan colors which are fast drying colors made by grinding the pigments in Japan dryer. These colors can be bought from any paint dealer in paste form and reduced to the proper working consistency with turpentine.

**Dyeing ACOUSTI-CELOTEX**

When an all-over shade darker than the natural color of ACOUSTI-CELOTEX is desired, any of the commercial water stains for dyeing wood may be used without sizing. These are mixed in hot water and applied cold in accordance with manufacturers specifications. The stain can be applied with a large brush or sponge.

Oil stains can be used if desired and will often give a more even color. They tend to harden the surface slightly but do not appreciably affect the acoustical value.

**Painting Type B, Type BB & Type C ACOUSTI-CELOTEX**

Where all-over tints are wanted, a paint of sufficient body to cover the natural color of the ACOUSTI-CELOTEX must be used. Such paints fill the pores and harden the surface and should be used only on Type B, Type BB & Type C ACOUSTI-CELOTEX. The acoustical value of these types is not affected.

Calcimine or any of the standard brands of cold water paint, including those of the washable type, may be applied to ACOUSTI-CELOTEX without sizing. For best results with calcimine, a small amount of glue should be added to the mixture.

A more durable surface can be made by sizing ACOUSTI-CELOTEX with a glue size and painting it with standard lead and oil paint. This makes a hard, washable, light-reflecting surface which still retains all of its sound absorbing value because of the perforations.

*See Detail Sheet, Page 9, for ACOUSTI-CELOTEX designs.*
REGULAR ASHLAR PATTERN

HERRING BONE PATTERN

SQUARE TILE PATTERN

WALL & CEILING DESIGNS FOR ACousti-CELOTEx

F.S. SECTION THRU BEVEL

SCALE 1" = 1'-0"
ACOUSTI-CELOTEX

ACOUSTI-CELOTEX is a highly sound absorbing, water proofed cane fibre board manufactured for sound control, including acoustical correction, sound deadening and general room quieting. It is made either with or without sound absorbing perforations.

ACOUSTI-CELOTEX, properly applied, produces quiet, comfort and the clear and distinct hearing of speech and music, free from echoes and excessive reverberation.

ACOUSTI-CELOTEX may be applied on plane wall and ceiling surfaces and on those of single or double curvature in buildings during or after construction. It produces definite and effective acoustical and decorative results in:

Armories  Composing Rooms  Lecture Rooms  Reading Rooms
Auditoriums  Computing Rooms  Libraries  Residences
Ball Rooms  Corridors  Lodge Rooms  Restaurants
Banking Rooms  Court Rooms  Mailing Rooms  School Rooms
Banquet Halls  Dining Rooms  Music Rooms  Telegraph Rooms
Billiard Rooms  Factories  Offices  Telephone Rooms
Bowling Alleys  Halls  Printing Plants  Temples
Churches  Hospitals  Radio Studios  Theatres
Club Rooms  Laboratories  Railway Stations  Typewriting Rooms

DISTINCTIVE QUALITIES

1—ACOUSTI-CELOTEX absorbs sound—

The various types have definite, predetermined, absorbing values which are not altered by the manner of application. There is a type of ACOUSTI-CELOTEX for every job.

2—ACOUSTI-CELOTEX is easy to apply—

It is a structural material in tile form, light in weight, convenient to handle, delivered to the job a complete finished product ready to apply to walls or ceilings. A good mechanic can nail or cement it in place.

3—ACOUSTI-CELOTEX is permanent—

It forms a part of the building in which it is used, is not subject to deterioration and will not require replacement.

4—ACOUSTI-CELOTEX requires no membrane—

It requires no cloth or other covering which must be renewed from time to time.

5—ACOUSTI-CELOTEX is sanitary—

It is a water-proofed fibre board which does not attract vermin nor support bacteria culture.

6—ACOUSTI-CELOTEX may be decorated—

It has a pleasing, soft texture surface, light tan in color, which, undecorated, harmonizes with the decorative scheme of most interiors. This surface also is ideal for the application of designs in the full range of colors, producing any desired effect. It forms a strong bond with gypsum plaster, making it an excellent surface for the application of mouldings, borders, rosettes or any form of plastic ornamentation.
INTRODUCTION

The principle of acoustics, of course, has long been known to science, but the practice of acoustical correction in buildings is a rather recent development. It has grown with the new and larger auditoriums, and with the realization of the greater necessity for proper sound control. Controlling sound better favors hearing conditions and reduces bothersome noises. Talking pictures, radio broadcasting and reception, have directed more attention to the problem of controlling sound in an interior after the sound has been created.

At the start, many experiments were tried to control sound and better hearing conditions. Materials of various kinds were placed on the walls and ceilings, such as, fabrics and other materials which could be considered no more than temporary expedients. What was needed was a substance that would correspond to plaster—which was permanent, could be decorated, would be fireproof, and would lend itself to better architectural effects and enhance the beauty and utility of auditoriums and interiors. Such a material has been found in a plaster which has a porous structure and yet which has a hard, permanent surface, suitable for decorative effects of all kinds without detracting from its acoustical properties.

Certain-teed Products Corporation realized the need for such acoustical materials. To furnish these requirements, Certain-teed made a wide search to find the material best suited that would be worthy of the reputation of the Certain-teed Products Corporation. The material finally decided upon is Kalite, the first acoustical plaster to have the basic properties necessary to achieve the results most necessary to modern construction.

Kalite is a highly cellular plaster that absorbs sound. It is made of carefully graded and sized pumice of a special variety, mixed with calcined gypsum and other ingredients. When the plaster sets, there are minute air spaces around the pumice particles. Through the body of the plaster, these small air spaces intercommunicate either directly or through the porous structure of the pumice to produce those absorbent qualities of sound, necessary in a good acoustical or sound absorbing material.

Certain-teed presents Kalite Sound Absorbing Plaster, only after thorough research and test and practical application on many outstanding buildings in which it has been in service. It may be specified by architects and applied by contractors with full confidence that the job will be both practical in application and fully satisfactory in results.
KALITE SOUND ABSORBING PLASTERS

SOUND

Sound is the condensations and refractions of the air that travel at about eleven hundred feet per second in waves, and these sound waves must be properly controlled if good hearing is to be had.

Comparative Chart Showing Speed at Which Sound Travels...

<table>
<thead>
<tr>
<th>Material</th>
<th>Speed (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane</td>
<td>264</td>
</tr>
<tr>
<td>Sound Travels</td>
<td>1144</td>
</tr>
</tbody>
</table>

When sound strikes a hard reflective surface, such as ordinary plaster or other dense surface material, it sets up a conflicting reverberation which causes great distortion of sound—this is bad acoustics. An ordinary plaster wall may reflect ninety-seven percent of the sound that strikes it, and since sound travels fast, it is many seconds before a sound wave spends itself in a room finished with ordinary plaster.

Sound Absorbing Efficiency

A rule or method of expressing sound absorbing values of a given acoustic material has been largely adopted by architects to express the efficiency of the acoustic material under consideration and is based on a standard frequency of 512 double vibrations, which is a pitch range midway between low tones on the scale and higher pitches of sustained speech and music.

The selection of this frequency of 512 double vibrations does not tell the entire story, for in actual practice the noises encountered in office buildings, schools, auditoriums, and the like, range from the low pitch of 128 double vibrations to 1,024 double vibrations.

This scale range embraces the more common mechanical noises and the higher tones encountered in lecturing, music, and the like.

It becomes apparent, therefore, when determining the value of any sound-absorbing material, the entire
KALITE SOUND ABSORBING PLASTERS

range from 128 to 1,024 double vibrations must be embraced and the average coefficient of sound absorption, possessed by any given material, must be used to determine the number of sound absorption units per square yard of surface.

Since the precise acoustical results to be obtained in any room or building can be accurately determined, it is self-evident that the lower tones or frequencies embraced within the pitch scale of 128 to 512 double vibrations must be taken into account, and serious errors with consequent bad results have been due to the neglect of proper consideration of these lower tone values.

Engineering services are available to the architect or owner with regard to assisting in the solution of any problem in sound control, acoustical correction, or noise reduction.

SOUND ABSORBING PLASTERS

The basic requirement of an acoustical plaster is that it absorb sound, and to do so it must be porous. To obtain this porosity, in the plasters other than Kalite, three different methods of manufacture have been used.

One type of acoustical plaster consists of an aggregate of small, evenly graded particles held together at points of contact by a thin cement binder. The particles must be of an even size to prevent smaller particles from filling the spaces between the larger (as sand fills the spaces in gravel) and the binder must be thin enough to keep from filling spaces between the aggregate. Such plaster is difficult to work and does not spread easily. In plastering terms, it is known as "short working."

A second type of acoustical plaster is made with asbestos or similar fibre held in a binder. When water is absorbed, the bundles of fibres swell. When dried, they leave small voids which give some porosity to the plaster. While supplying this type plaster increases the porosity, and is simple in a laboratory sample, in actual application it is difficult to effect at the correct point of workability. Frequently stippling at the wrong time pulls the plaster off the wall or ceiling. Such plasters usually have plenty of "stretch" and are generally liked by mechanics.

Other acoustical plasters depend upon chemical action (the formation of gas in the plaster) to produce porosity. These bubbles, when formed in just the right quantity and at the right time, leave the plaster somewhat porous. The difficulty of controlling the chemical action has hindered the development of this type plaster.

KALITE SOUND ABSORBING PLASTER

Kalite Sound Absorbing Plaster involves entirely different principles of securing absorption which make it fool-proof, give it high porosity and ready workability. Kalite is largely composed of small particles of pumice, a stone made light and porous by volcanic action. A selected pumice which has proper characteristics of porosity is ground, carefully graded and processed in the Kalite Company plant, Imperial County, California. It is mixed with a proper binder and a special compound, and shipped to the job, where it is only necessary to add water to make it ready for application. The porosity is obtained in mixing. Small bubbles form in the mix by natural physical action. These bubbles make the plaster light and foamy as a shaving lather, and easy to work. These bubbles are also the cause of Kalite plaster remaining porous after it sets and dries. The lightness of the ingredients makes Kalite easy to apply; the foaminess makes it easy to spread; and the entire process insures unusual sound absorbing efficiency with a minimum dependence upon human skill.

TYPES OF KALITE PLASTERS

Kalite H Plaster is of gypsum binder, is of medium-sized aggregate, of light buff color, and can be finished with float or trowel. It is advocated where high sound absorption value is desired and the coarse texture is not objectionable.

Kalite F Plaster is of gypsum binder and of fine-size aggregate. It can be had in either natural gray or light buff color. It is advocated for use where a smooth trowel, or light sand float finish is desired.
Kalite Hydraulic Plaster is of Portland cement binder and medium-size aggregate, furnishes high sound absorption, and is advocated to be used where the treated area is exposed to dampness or the elements; as for example in swimming pools, etc.

**ABSORPTION CO-EFFICIENT OF KALITE PLASTERS**

<table>
<thead>
<tr>
<th>Material and Thickness</th>
<th>Frequency</th>
<th>Authority and Date</th>
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<tr>
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<td></td>
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<td>H Finish 1/2&quot;</td>
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<tr>
<td>3/4&quot;</td>
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<td>Knudsen 11-24-30</td>
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</tbody>
</table>

(Higher or lower sound absorption values can be had by increasing or decreasing the thickness of Kalite)

**Covering Capacity** — Applied 1/2" thick, Kalite will cover about 100 yards per ton of material.

**Light Reflection** — Light reflection factor of Kalite by Curtiss Lighting Company of Chicago, 65.3.

**Tensile strength**, average of four specimens, 76 lbs. per square inch.

**MIXING AND APPLICATION**

The following proportions are based on one sack of Kalite Plaster and should be observed also in the case of mixing two or more sacks in one batch:

**Machine Mixing**

Put 2 gallons of cold water in the mixer. Add 1 sack of Kalite Plaster. Run mixer until the plaster is thoroughly and uniformly dampened. Then add water slowly until the plaster is workable (about two more gallons will be necessary). Mix thoroughly for not less than 3 minutes. If the plaster is not sufficiently thin for application with a trowel by this time, add a small amount of water slowly as at this time only a slight amount of water is necessary to make the plaster ready for application.

**Hand Mixing**

Put 3 gallons of water in the mortar box. Add the Kalite and mix thoroughly until the plaster is uniformly dampened. Then slowly add sufficient water to get the proper consistency of the mix. The mixing must be done thoroughly until the mass has a light and fluffy appearance.

**APPLICATION**

In applying all types of Kalite Sound Absorbing Plaster, lay on the material with the trowel, working in one direction only.

**For 1/2" Thickness of Kalite H and F Plasters**

Apply Kalite with a trowel over gypsum scratch or brown coat to a thickness of 1/4" and double back immediately with another quarter inch to make the 1/2" thickness.

**For 3/4" Thickness of Kalite H and F Plasters**

Apply Kalite with the trowel over gypsum scratch or brown coat to a thickness of 3/8" and double back immediately with another 3/8" coat to make 3/4".

In general, doubling back can be done immediately, but under certain job conditions of cold or very damp weather, or where there is not sufficient ventilation, it is best to wait until the first coat has taken up or reached its initial set before doubling back.

**Applying Kalite Hydraulic Plaster**

This is applied in the same manner as any other Portland cement plaster; however, it is understood that the base coats be of Portland cement plaster and will be applied and cured as per the Portland Cement Association’s specifications and recommendations.

Since Kalite plaster is very light in weight, the plasterer needs to use but little strength or pressure in applying — merely sufficient to keep it in place. Aside from the above requirements, Kalite is applied in the same manner as ordinary gypsum plaster.

**FINISH OF KALITE PLASTER**

To obtain smooth or fine texture finish, the final coat of Kalite plaster must be carefully floated to re-
move the welt and trowel marks before the plaster sets. After the floating operation, lightly pass the dry trowel over the surface. The plaster should not be sprinkled with water while floating.

To obtain sand float finish, after first coat of Kalite has been applied, rodded and darbed and reached its initial set, apply the second or doubled up coat of Kalite laid down as smooth as possible and lightly floated in circular motion with ordinary wood float.

SPECIFICATIONS

Where acoustical treatment is shown on plans and called for in general specifications, furnish Kalite Acoustical (Sound Absorbing) Plaster, as sold by the Certain-teed Products Corporation of New York City, and apply same in accordance with this manufacturer’s directions.

DECORATION

Kalite Acoustic Plaster is furnished in its natural color, a light gray, and in a standard buff cream color, which is integrally mixed, and does not need additional decorating.

Where decorative effects are desired in bright or pastel shades of any colors, non-bridging lacquers or special dye colors are used over the natural color of the Kalite Plaster, and these dyes are applied either by spray or brush methods.

It Is Most Important that only the materials specified and recommended by the manufacturers of Kalite should be used for decoration, as owing to the very minute pores in the Kalite Plaster, which give Kalite its high sound absorption properties, can easily be filled up and rendered useless by application of oil or zinc paints or any compounds which have not been thoroughly tested out and recommended by the manufacturers.
KALITE CAST ACOUSTIC

This product is a high grade material for plain and ornamental casting purposes; it is of a gypsum binder and furnished either extremely fine or medium rough, combining high sound absorbing properties with structural strength, sharp outline of arrises, decorative detail in the finished casting, and a most pleasing texture and appearance.

Kalie Cast Acoustic has been thoroughly proven in commercial work and has been successfully developed both from the technical standpoint of acoustics and practical workability.

The base of Kalite Cast Acoustic is a light, porous, volcanic silica of extreme purity, mined by the Kalite Company from its deposits in the Salton Sea area, Imperial County, California. The chemical analysis is approximately that of window glass.

Unusual forces of nature and the geological conditions which prevail in this area formed a material having rare and unique physical characteristics. This material has high structural strength. It is of unusual crystalline form and even when ground to the finest sizes, the individual particles maintain their strength and porosity. When properly blended to form casting plaster, it yields a resultant product unequalled by other materials on the market for high sound absorption, strength, and sharp lined casts.

Kalie Cast Acoustic opens another and extremely interesting avenue to the architect and engineer to combine sound control with ornamental and decorative design at a reasonable cost.

Kalie Cast Acoustic is supplied in two grades. Grade A being of medium coarse texture and Grade D extremely fine texture.

Kalie Cast Acoustic will carry colors integrally mixed, or may be cast in its natural gray color and afterward decorated with non-bridging lacquers or approved lactic dyes, without impairing its sound absorbing properties to any practical extent. Great care must be exercised in selecting the proper lacquer or dyes and the advice of the manufacturer on this matter must be followed if evident acoustic results are to be obtained.

Kalie Cast Acoustic is marketed in eighty pound bags already prepared for casting and all that is necessary is to add a small amount of water. The casting is made by the dry tamp method. An experienced ornamental plasterer or imitation stone worker, familiar with ordinary Plaster of Paris, can use Kalite Cast Acoustic with full confidence of turning out uniform and excellent work.

Kalie Cast Acoustic can be cast in either metal, wood, glue, or plaster moulds. Practically any natural stone can be imitated with Kalite.

Kalie Cast Acoustic is recommended for ornamental cast work in all types of buildings such as, assembly rooms, libraries, theatres, churches, auditoriums, lobbies, and corridors, public meeting rooms, or wherever it is desirable to combine sound control with decorative architectural motives.

Kalie Cast Acoustic is erected in place on the job in the same ordinary manner as stone tile work, and involves no intricacies of installation.
The main library room of this new structure is outstanding for architectural renaissance design and the excellent acoustic properties of the room. This main room is approximately 128 feet long and 47½ feet wide by 26 feet high.

The entire ceiling comprises highly ornamental designs, corbelling and step moulding. This has all been accomplished by Kalite Cast Acoustic, the casts being made on the job. Some of these panels on this job measure well over 30 square feet in surface area.

These cast panels were fastened to the ceiling in the usual manner for attaching staff work and, as finished, the ceiling is highly decorated in various tones and colors, giving a most pleasing appearance.

In numerous side wall panels, Kalite Cast Acoustic is used from floor level up to a height of 5 feet, and the side walls from this point on are plastered with Kalite Acoustic Plaster of a smooth texture and finish.

**ABSORPTION CO-EFFICIENTS OF KALITE CAST ACOUSTIC**

<table>
<thead>
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<th>Material and Thickness</th>
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<th>512</th>
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<td>.29</td>
<td>.43</td>
<td>.55</td>
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</table>

(Sound absorption can be increased by increasing the thickness of Kalite)
KALITE SOUND ABSORBING PLASTERS

(Kalite's most recent achievement)

Interior of the International Music Hall, Rockefeller Center (Radio City Section), New York City. Entire fluted ceiling and walls produced in Kalite Sound Absorbing Plaster.

Kalite Sound Absorbing Plasters


Kalite installed to quiet the effect of E. P. Hudson Co., Los Angeles, Calif. Parkinson & Parkinson, Los Angeles, architects.
Kalite Sound Absorbing Plasters

Application of Kalite Sound Absorbing Plaster in the new Los Angeles County General Hospital at Los Angeles, California. Allied Architects Association, Mr. Edwin Bergstrom, Chairman, Architects. In point of total yardage, this is the largest acoustical plaster job in the world.

New Los Angeles County Hospital. Corridors and ceilings of all rooms, kitchens, etc., are plastered with Kalite Sound Absorbing Plaster. Approximate 130,000 square yards. Job awarded to Kalite on basis of competitive tests.
PARTIAL LIST OF KALITE INSTALLATIONS

Radio City Theatre (Music Hall), New York, N. Y.
Loew's Boulevard Theatre, New York, N. Y.
Radio City Theatre (New Roxy), New York, N. Y.
Radio City Building No. 10
TransLux Theatre, 49th Street, New York, N. Y.
Midway Theatre, Philadelphia, Pa.
R.K.O. Theatre, Trenton, N. J.
Williamsburg Theatre, Williamsburg, Va.
Lincoln Bank Building, Brooklyn, N. Y.
Barnes Trust Building, New York, N. Y.
Continental Bank Building, New York, N. Y.
Yale University (Athletic Office), New Haven, Conn.
Yale University (Wheelock Quadrangle), New Haven, Conn.
Yale University (film and College Quadrangle), New Haven, Conn.
Yale University (I and IX Quadrangle), New Haven, Conn.
Wooner College Auditorium, Wooner, Ohio
Penn State College (Two Buildings), State College, Pa.
Metropolitan Life Insurance Building, New York, N. Y.
Renesia Dairy Building, Brooklyn, N. Y.
Ex-Lax Building, Brooklyn, N. Y.
Brooklyn State Hospital, Creedmoor, N. Y.
Library Building, Providence, R. I.
Public School No. 76, New York, N. Y.
Hotel 10 Park Avenue, New York, N. Y.
Vitaphone Studios, Brooklyn, N. Y.
Steuben Junior High School, Milwaukee, Wisc.
Southern California Edison Building, Los Angeles, Calif.
Title Guarantee & Trust Company, Los Angeles, Calif.
Los Angeles County Hospital, Los Angeles, Calif.
Canadian Bank Building, Los Angeles, Calif.
Warrer Brothers Theatre, San Pedro, Calif.
Warrer Brothers Theatre, Beverly Hills, Calif.
Warrer Brothers Theatre, Wilshire Blvd., Los Angeles, Calif.
Elliot Junior High School, Pasadena, Calif.
Public School—32d Street—Los Angeles, Calif.
Public School—97th Street—Los Angeles, Calif.
Library and Dining Hall, Claremont College, Pomona, Calif.
Myra Hershey Hall, U. C. L. A., Los Angeles, Calif.
Associated Telephone Building, Covina, Calif.
Southern California Telephone Bldg., 433 S. Olive, Los Angeles, Calif.
Southern California Telephone Bldg., Hollywood, Calif.
Southern California Telephone Bldg., Hermosa Beach, Calif.
United Artists Theatre, Pasadena, Calif.
Los Angeles Theatre, South Broadway, Los Angeles, Calif.
Whitney Baptist Church, Whittier, Calif.
Republic Bank Building, Dallas, Texas
Baywood Theatre, San Mateo, Calif.
Excelsior Theatre, San Francisco, Calif.
First National Bank, Ontario, Calif.
Valley Bank, Phoenix, Arizona
State Mutual Bldg. & Loan Ass'n Bldg., Los Angeles, Calif.
Little Lake School Auditorium, Santa Fe Springs, Calif.
San Diego Gas & Electric Corp., San Diego, Calif.

California Institute of Technology, Pasadena, Calif.
Private Office, President, University of California, Berkeley, Calif.
Private Office, Dr. A. B. Cecil, Los Angeles, Calif.
E. F. Hutton Co., Los Angeles, Calif.
Residence of J. B. Murray, Beverly Hills, Calif.
Residence of C. Van Wyck, Pasadena, Calif.
Lake Avenue Church, Pasadena, Calif.
Loegh Beach Auditorium, Long Beach, Calif.
Hughes Franklin Theatre, Whittier, Calif.
Ventura Court House, Ventura, Calif.
Valley Maid Dairy, Fletcher near San Fernando Road, Los Angeles, Calif.
Progress Bulletin Building, Pomona, Calif.
Fletcher Street School, Los Angeles, Calif.
Bell School, Los Angeles, Calif.
Doheny Memorial Library, University of Southern California, Los Angeles, Calif.
Fordham School, 3751 South Harvard, Los Angeles, Calif.
Fox Film Studios, Los Angeles, Calif.
Garfield School, Los Angeles, Calif.
Bank of America Building, Los Angeles, Calif.
Fox Theatre, El Centro, Calif.
Security First National Bank of Los Angeles, 6th & Spring, Los Angeles, Calif.
A. H. Karpe Job, Bakersfield, Calif.
Parkinson Apartments, Santa Monica, Calif.
Banning School, Wilmington, Calif.
Coalinga School, 2nd & Hobard, Los Angeles
Veterans War Memorial, San Francisco, Calif.
New San Francisco Opera House, San Francisco, Calif.
School at Melrose & Detroit, Los Angeles, Calif.
Edison High School, 65th & Hoover, Los Angeles, Calif.
Ritter School, 110th Street, Los Angeles, Calif.
United Artists Theatre, Berkeley, Calif.
Beverly Hills High School, Beverly Hills, Calif.
Oscar Combs School, Eastman & 9th, Los Angeles, Calif.
Gardena School, Los Angeles, Calif.
Queen of Angels Hospital, Los Angeles, Calif.
John Marshall School, Los Angeles, Calif.
Lankershim School, Los Angeles, Calif.
Southern California Telephone Bldg., 4th & Lorena, Los Angeles, Calif.
George Washington School, Los Angeles, Calif.
Victoria Theatre, Berendo & Pico, Los Angeles, Calif.
Additional work for Fox Film Studios
University of California, Los Angeles Branch at Westwood
A room in State Building, Los Angeles, Calif.
Venice High School, Venice, Calif.
Rives-Strong Building, Los Angeles (remodeling)
Fern Avenue School, Los Angeles, Calif.
First Baptist Church, Upland, Calif.
Library Building, Fresno, Calif.
California Institute of Technology, Pasadena, Calif., — Additional Work
Knights of Columbus, 9th & Bonnie Brae, Los Angeles, Calif.
Branch City Hall, Van Nuys, Calif.
INSTRUCTIONS FOR APPLYING

MIXING

In mixing Kalite it is important that mixer, mortar box, and tools be kept clean at all times, and that only clean water be used.

It is recommended that mixing be done in a mechanical mixer. The following proportions are based on 1 sack of Kalite Plaster and should be observed also in the case of mixing 2 or more sacks in one batch.

Put 2 gallons of cold water in the mixer:

Add 1 sack of Kalite Plaster. Run mixer until the plaster is thoroughly and uniformly dampened, then add water slowly until the plaster is workable (about 2 more gallons will be necessary). Mix thoroughly for not less than 3 minutes. If the plaster is not sufficiently thin for application with a trowel by this time, add a small amount of water slowly, as at this point only a slight amount of water is necessary to make the plaster ready for application.

CAUTION: Avoid flooding Kalite Plaster with too much water at the start as this tends to wash out the light pumice particles.

WHEN MECHANICAL MIXER IS NOT AVAILABLE:

Put 3 gallons of cold water in the mortar box. Add 1 sack of Kalite Plaster. Mix thoroughly until the mass is uniformly dampened, then slowly add sufficient water to get proper consistency of mix. The mixing must be done thoroughly until the mass has a white and fluffy appearance.

APPLYING

Base Coat must be thoroughly dry before application

In applying all types of Kalite, trowel only in one direction.

$\frac{1}{2}$” Thickness

For $\frac{1}{4}$” thickness, apply Kalite Regular with a trowel over dry gypsum scratch or brown coat to a thickness of $\frac{3}{4}$” and double back immediately with another $\frac{1}{4}$” to make $\frac{3}{4}$” thickness.

$\frac{3}{4}$” Thickness

For $\frac{3}{4}$” thickness, apply Kalite Regular with a trowel over dry gypsum scratch or brown coat to a thickness of $\frac{3}{4}$” and double back with an-
KALITE ACOUSTICAL PLASTER

other 3/8" coat to make 3/4" thickness. In general doubling back can be done immediately but under conditions of cold or very damp weather or where there is insufficient ventilation it is desirable to wait until the first coat has reached its initial set before doubling back.

1" Thickness

For 1" thickness, apply Kalite Regular in 2 coats of 3/8" each as outlined under application of 3/8" thickness. The first 3/8" coat must be allowed to dry thoroughly before the second 3/8" coat is applied.

Finish of Kalite Regular

To obtain smooth finish on Kalite Regular Plaster, the final coat must be carefully dabbed and immediately after the darby, lightly trowelled. The plaster must not be sprinkled while dabrying.

Finish of Kalite Fine Finish

Apply Kalite Regular as outlined to 3/4" less than final thickness, to allow for 3/8" finish coat of Kalite Fine Finish. The Kalite Regular base coat is not trowelled but is left after the darby or rod. Apply Kalite Fine Finish — 3/4" thick after the Kalite Regular base coat has set, trowelling smooth in one direction only and with as few strokes as possible.

If Kalite Regular base coat has dried, it should be thoroughly dampened to prevent too great suction when the Kalite Fine Finish is applied.

Application of Kalite Hydraulic

Kalite Hydraulic is applied in the same manner as any other Portland cement plaster.

Screeds

To insure proper thickness of Kalite, screeds should be placed on ceiling or wall surface and plaster coat leveled up to required thickness.

Special Notes

Since Kalite is very light, the plasterer needs to use but little strength in applying, merely sufficient to keep it in place.

Aside from the above special requirements, Kalite is applied the same as ordinary gypsum plasters and the usual precautions should be followed.
R. GUASTAVINO COMPANY

40 Court Street
BOSTON, MASS.

500 Fifth Avenue
NEW YORK, N. Y.

Representatives

Atlanta, Ga.
Cleveland, Ohio

Chicago, Ill.
Detroit, Mich.

Cincinnati, Ohio
New Orleans, La.

St. Louis, Mo.
San Francisco, Calif.

Pittsburgh, Pa.

Canada: R. Guastavino Co. of Canada, Ltd.
1135 Beaver Hall Hill, Montreal

Engineers and Builders of Structural Timbrel Arches
And Vaults for Ceilings and Floors
"Guastavino Construction"

Services
This Company maintains a competent engineering staff to work and consult with architects on all problems concerning the use of its products, both structural and acoustical.

Exhibits
The Guastavino Company maintains a complete exhibit of its products in the Architects' Sample Corporation at 101 Park Avenue, New York, N. Y.

Manufacturers of Decorative Ceramic Tile and Sound Absorbing Masonry Materials Having an Architecturally Structural Character

Products
Products manufactured by us include:
Special Ceramic Tile, glazed and unglazed.
Rumford Ceramic Acoustic Tile.
Akoustolith sound-absorbing stone, in tile and ashlar sizes, patented.
Akoustolith sound-absorbing plaster, patented.
Castaoustic sound-absorbing casting plaster.

Special Cast Shapes in Akoustolith
Acoustic Materials
Should Have Architectural Character

When an architect designs an interior it should not be necessary to change its character on account of the necessity for use of acoustical materials. Many otherwise fine interiors have lost their architectural and structural character through the use of incorrect material from an esthetic as well as acoustical viewpoint.

In designing and producing sound absorbent materials, Rafael Guastavino in collaboration with the late Professor Wallace C. Sabine of Harvard University succeeded in producing materials which had great acoustical value as well as architectural, structural, and fireproof values. This idea was of the greatest importance and has been so recognized by the architectural profession as witnessed by the number and importance of the works entrusted to us.

If the interior is designed with a masonry character, this character should not be destroyed by the use of acoustic materials but rather enhanced by them. If a plaster interior is desired the material should carry out this effect. If a stone or tile effect is desired, these should be produced.

It will be readily noted from typical illustrations of our work that, under a wide variety of conditions and styles of architecture, the architectural effect desired has been carefully and successfully produced.

Special Materials for Special Purposes

Sometimes it is as unwise to have too much sound absorbing material in a room as it is to have too little. So much depends on the size and shape of the room as well as its architecture, that the selection of the best materials to assure proper acoustics is one requiring mature experience.

In order to take care of practically all conditions we have produced two types of masonry acoustic tiles or ashlar and two of acoustic plaster. We produce glazed and unglazed ceramic tile used in our arches and domes. This latter is the well known original Guastavino tile and has been used for more than 45 years in constructing many of the largest domes and vaulted ceilings in the world.

Where Tile Effects in Ceilings, Arches and Sidewalls Are Desired—"Rumford" Tile—"Akoustolith" Tile

"Rumford" Tile—This is a ceramic product and was the first masonry material of high acoustical efficiency.

"Akoustolith" Tile—We believe this is the most efficient masonry sound absorbing material on the market (see page 5). It can be obtained in a variety of textures with color range practically unlimited and can be moulded or cast into special shapes as required.

For Side Walls Requiring Stone Character

Where it is desired to carry out the effect of a stone ashlar in sizes up to 15x30 ins. and larger. Akoustolith Ashlar sound absorbing artificial stone should be used. Akoustolith can be made to match very closely the color and texture of natural stones (see page 1).

For Side Walls or Ceilings in Plaster

Where expense is a controlling factor in the selection of acoustic materials or a plaster finish is desired, we suggest:

"Akoustolith" Plaster—A material with high sound-absorbing qualities, which is applied as a finish coat over the ordinary plaster base coat (see page 7). Akoustolith Plaster can be tinted and textured as desired, but should be used only on plain surfaces and applied with the trowel. Mouldings, ornaments, etc., can be cast on the job in our "Castacoustic" Casting Plaster—This latter material using a gypsum binder can be cast, backed up and set in the usual way for plaster ornament, yet retaining its high acoustical efficiency (see page 8).

A FEW OUTSTANDING INSTALLATIONS IN GUASTAVINO CONSTRUCTION

Cathedral of St. John the Divine, New York, N. Y., Cram & Ferguson, Architects.
Grace Cathedral, San Francisco, Cal., Lewis P. Hobart, Consulting Architect; Cram & Ferguson, Consulting Architects.
St. Albans Cathedral, Washington, D. C., Frohman, Robb & Little, Architects.
 Nebraska State Capitol, Lincoln, Neb., Bertram Grosvenor Goodhue and Gough, Goodhue & Gough, Architects.
Riverside Church, New York, N. Y., Felton, Allen & Collins, Architects.
Chicago University Chapel, Chicago, Ill., Bertram Grosvenor Goodhue Assoc., Architects.
Temple Emanuel-El, New York, N. Y., Robert D. Kohn, Charles Butler and Clarence S. Stein, Architects; Mayers, Murray & Butler, Associate Architects.
Epworth Euclid M. E. Church, Cleveland, Ohio, Bertram Grosvenor Goodhue Assoc., Architects; Walker & Weeks, Associate Architects.
Sacred Heart Church, Washington, D. C., Murphy & Olmstead, Architects; Magennis & Walsh, Associate Architects.
First Unitarian Church, Chicago, Ill., Demaison B. Hull, Architect.
Federal Reserve Bank, New York, N. Y., York & Sawyer, Architects.
Department of Commerce Building, Washington, D. C., York & Sawyer, Architects.
U. S. Post Office, Custom House and Courthouse, Dubuque, Ia., Supervising Architect, Treasury Department.
Oklahoma City Post Office, Oklahoma City, Okla., Supervising Architect, Treasury Department.
Gerard College Chapel, Philadelphia, Pa., Thomas Martin & Kirkpatrick, Architects.
Church of St. Andrew and St. Paul, Montreal, Canada, H. L. Fetherstonhaugh, Architect.

[4]
AKUSTOLITH

Sound Absorbing Artificial Stone in Tile or Ashlar Form

What “Akoustolith” Is

AKUSTOLITH is an artificial stone, having a sound-absorbing value believed to be greater than any other masonry material.

Its acoustical value was first determined by laboratory tests of the late Professor Wallace C. Sabine at Harvard University and more recently by the United States Bureau of Standards. These latter tests give the coefficient of absorption of AKUSTOLITH Tile up to 90% at 512 cycles (C4) for a thickness of 2 ins., the efficiency varying according to thickness and grade.

Its Uses

Owing to its light weight and facility of manufacture AKUSTOLITH is easily adapted to plain or elaborate architectural forms. It is used in tile form on walls, ceilings, arches, vaults and other architectural forms of a constructive nature. In ashlar form it has been used considerably by architects on sidewalls in lieu of stone work and has been successful in meeting their requirements.

Textures and Colors

It has a fine granular surface and is made in textures similar to that of natural stones or as desired. It is made in colors ranging from gray white through various shades of buff, brown or other colors of the natural stone. It is genuine masonry, non-combustible and non-smoke producing. It will not warp. Moisture has no effect on its structure and it can be easily cleaned by vacuum or by washing.

Sizes and Weight

AKUSTOLITH is manufactured in any size from the smaller tile dimensions, 3x6 in.; 4x8 in.; 5x10 in.; 6x12 in. and 8x16 in. usually about 1 in. thick and for this thickness weighs about 4 lbs. per sq. ft. This light weight permits AKUSTOLITH to be used in places where heavier material would be impracticable—for instance, ceiling work.

For wall ashlar, AKUSTOLITH can be made in sizes up to 30x60 in. from 1¼ to 2 in. thick depending on size. It can also be moulded or cast in the usual architectural forms. The distance from the backing to the finish face of AKUSTOLITH will vary from 1½ in. for the smaller tile sizes to 3 in. for the larger ashlar sizes.

Its Installation

AKUSTOLITH Tile used on ceilings has primarily been installed in connection with our regular GUASTAVINO Arch Construction, using it as a soffit course and backing up with two or more layers of our rough tile construction. It is also being installed by applying it directly to the soffit of concrete floor slabs or to wire lath and cement plaster ceilings.

For sideward installations it can be cemented directly to any of the many masonry surfaces without scratch coat, if the surface is reasonably true.

AKUSTOLITH TILE SPECIFICATIONS

(a) As Part of Guastavino Timbrel Arch Construction—

Where indicated on drawings, or as hereinafter specified, the ceilings shall be constructed of Timbrel Tile arches by R. GUASTAVINO COMPANY, New York and Boston, with the soffit of the arch faced with (give size of tile) AKUSTOLITH sound absorbing stone tile. Tile to be laid in pattern shown.

Arch construction in addition to the soffit course of AKUSTOLITH Tile shall consist of not less than two layers of good, hard burnt, rough, semi-porous terra cotta tile, ranging from 1x6x12 ins. to 24 ins. in length. Tile shall be laid in 1 to 2½ mix Portland cement mortar and reinforced with steel rods or bars between the courses or between the ends of the tile of the same course as may be necessary.

Centering—The contractor for the above vaulting shall provide and erect all centers required for the installation of his work. Centering shall remain in place until the mortar is set and hard, after which he shall remove all his centering from the building.

Vault Supports—The general contractor shall leave out recesses, or build masonry corbels or brackets in walls as well as any steel necessary for the support of the tile vaulting as shown on the working drawings of the architect and tile vault contractor.

(b) For Installing “Akoustolith” Tile Against Soffit of Concrete Floor Slabs—

Where indicated on the drawings, or as hereinafter specified, the ceiling or soffit of concrete floor slabs and beams shall be faced with AKUSTOLITH sound absorbing stone tile as manufactured by R. GUASTAVINO COMPANY, New York and Boston. Tile shall be (give size), laid in approved Portland cement mortar in patterns as shown, directly against the cement slab and beams which have been properly roughened and cleaned by others. Joints ¼ in., colored as directed with approved mortar colors.

(c) For Installing “Akoustolith” Tile on Metal Lath Ceilings—

Note for Metal Lath and Plastering Specifications: Where AKUSTOLITH is specified or indicated on ceilings, beams, etc., the metal lath foundation should be formed of 1 in. standard channels set 12 in. o.c., covered with 3/16 lb. metal lath.

Note for Plastering Specifications: Wherever AKUSTOLITH given two coats of Portland cement mortar, the last to be scratched.

Wall Work

Where indicated in drawings or hereinafter specified the side walls shall be finished with AKUSTOLITH sound absorbing stone manufactured by R. GUASTAVINO COMPANY, New York and as selected by the architect, and laid up in patterns as shall be cemented directly against the masonry wall with Portland cement mortar and anchored if necessary.
AKOUSTOLITH SOUND-ABSORBING PLASTER

Purpose
AKOUSTOLITH Plaster was developed under our patents in answer to a demand for an acoustic material which could be applied with a trowel. It is a lightweight masonry material, troweled on as a finish coat over the ordinary ground coats. Only the ordinary plasterer's tools are necessary.

Acoustic Qualities
AKOUSTOLITH Plaster has been tested at Jefferson Physical Laboratory, Harvard University, the U. S. Bureau of Standards, Washington, D. C., and other laboratories.

The graph developed from the Bureau of Standards test on AKOUSTOLITH Plaster ¼ in. thick shows an efficiency of 32% at 512 d. c., (C) to 59% at 2890 d. c. The test on ¼-in. plaster at the Jefferson Physical Laboratory shows an efficiency of 24% at C to 42% at C7.

It should be remembered that AKOUSTOLITH Plaster has been in use for years on many of the finest buildings in this country, and the claims made as to its efficiency have been completely justified.

Appearance
The texture, on account of the structure of the plaster, is similar to that of sand finish, but the general surface treatment may be varied as desired.

Color
In its natural color it is very light gray, almost white. It can be colored to practically any shade desired by the use of mortar colors.

Painting
Tinting after installation can be done by either the brush or spray method, using paint having a consistency of light oil stain. Special paints are manufactured for this purpose, but care must be taken in application so that porosity of the plaster is not impaired by bridging the pores.

Servicing of Jobs
It is our practice to serve each job in the United States with a representative at the starting of installation. This is usually done at no extra charge.

Covering Capacity
AKOUSTOLITH Plaster ¼ in. thick will cover from 100 to 110 yds. to the ton. At ½-in. thickness it will cover from 165 to 175 yds. per ton. It should be noted that AKOUSTOLITH Plaster ¼ in. thick, as actually applied on the job, is more efficient than other acoustic plasters ¼ in. thick, making the cost per unit acoustic plasters ½ in. thick, and much lower than the felled or fibrous acoustical correctives.

Acoustical Analysis Service
Upon receipt of plans and a description of furnishings, our engineering staff will make an analysis, and indicate where AKOUSTOLITH Plaster should be used to give satisfactory results. Plans should be sent to the nearest office.

Construction of the Plaster
Laboratory tests and actual installations have proved that the same surface texture does not make an efficient acoustic plaster. The granular appearance and intercommunicating porosity of AKOUSTOLITH Plaster as shown in the accompanying photographs, is the same throughout the entire thickness and is responsible for its high efficiency in absorbing sound. AKOUSTOLITH Plaster requires no floating, stippling or other mechanical processes after application to secure its efficiency. The method of securing the porosity of AKOUSTOLITH Plaster is fully covered by United States patents, and consequently equivalent results can be expected with no other plaster.

Permanence
AKOUSTOLITH Plaster is manufactured by a Company which has been continuously in the building construction field for nearly 50 years, and which has had an unsurpassed experience in the acoustic field. It is, and always has been, a fireproof material entirely unaffected by water. The surface is hard and it may easily be cleaned by washing. For this reason it has been used in many hospitals and other buildings where sanitation and washability are prime considerations.

AKOUSTOLITH Plaster has been used in practically every type of building and has been uniformly successful.

How Distributed
AKOUSTOLITH Plaster is sold direct to the plastering contractor f. o. b. factory, Woburn, Mass., packed in bags, and ready to use with the addition of water only. It can be applied by any intelligent plasterer following the specifications furnished by the manufacturer.

NOTES FOR SPECIFICATION WRITER
For New Buildings
Where AKOUSTOLITH Plaster is to be applied against masonry construction or wire lath the usual heavy scratch coat shall be applied, thoroughly covering irregularities. A brown coat shall be applied if necessary, according to manufacturer's specifications.

The base coats may be composed of gypsum, portland cement, or lime plaster. The surface on which the binder coat is to be applied shall be thoroughly cross-scored to provide a proper bond and shall be sufficiently wet to stop most of the suction.

When the scratch coat (or brown coat if used) is properly set but still "green," apply a ¼-in. binder coat composed of a rich mixture of hydrated lime and sand to be followed immediately with the finish coat of AKOUSTOLITH Plaster (½ or ¾ in. thick as specified), to be applied in strict accordance with the manufacturer's directions.
For Swimming Pools

Over swimming pools or other places where Akoustolith Plaster is to be applied on walls or ceilings exposed to continuous dampness, the base coats shall be composed of portland cement plaster and applied in accordance with the standard specifications of the Portland Cement Association. The binder coat shall be of the following proportions by weight: ¾ part portland cement, 1 part sand, ½ part hydrated lime. After the base coats have thoroughly dried and obtained their full shrinkage, same shall be dampened with water to stop most of, but not all, the suction. The binder coat shall then be applied ¼ in. in thickness and followed immediately with one coat of Akoustolith Plaster (thickness ½ or ¾ in. as specified).

Specication

Where acoustical treatment is shown on the plans and in the following spaces ...... it shall be Akoustolith Plaster.2 as manufactured by R. Guastavino Company of New York and Boston, applied (specify thickness ½ or ¾ in.) in strict conformance with the manufacturer’s directions.

CASTACOUSTIC PLASTER FOR ORNAMENTAL CEILINGS

Purpose

CASTACOUSTIC is a sound-absorbing plaster designed expressly for ornamental or coffered ceilings where acoustical treatment is desired, and where a ceiling having a period design or architectural character is required. (CASTACOUSTIC is not suitable for trowel application.)

Appearance

CASTACOUSTIC has a fine granular appearance and on high ceilings is scarcely distinguishable from ordinary plaster.

Acoustical Engineering

Refer to “Akoustolith Plaster.”

Structure

When mixed with the proper quantity of water, the mixture of CASTACOUSTIC Plaster is open and continuously porous from the finish face completely through its entire depth. This porous structure provides the highest acoustical efficiency.

Facing

A facing approximately 1 in. thick of CASTACOUSTIC Plaster should be used as far as possible.

Backing and Reinforcing

CASTACOUSTIC should be backed up with gypsum moulding plaster and reinforced as required. Reinforcing will depend on the size of the castings.

Moulds

The use of plaster moulds is recommended wherever possible instead of glue or gelatin moulds.

Undercutting

Except on heavy or massive relief, undercutting should be avoided.

Type of Ornament

Almost any type of ornamental work which can be cast in plaster moulds can be formed in CASTACOUSTIC Plaster. Elaborate ornament with sharp undercut sections is difficult to cast satisfactorily.

Speed of Set

CASTACOUSTIC will take its initial set in a little over one hour’s time. This speed of setting checks with the average job requirements, but can be altered to suit special conditions of casting. CASTACOUSTIC Plaster may be removed from the plaster moulds as soon as it has its initial set, but should be left for a longer period in glue moulds.

Color

In its natural color, CASTACOUSTIC is a very light gray, almost white. It can be colored to any shade by the use of mortar colors added by the plasterer.

Painting

Refer to “Akoustolith Plaster.”

Covering Capacity

The covering capacity of CASTACOUSTIC Plaster is as follows—applied 1 in. thick one ton will cover approximately 45 yards.

Sales Distribution

CASTACOUSTIC is sold direct to the plastering contractor f.o.b. factory, Woburn, Mass., packed in bags and ready to use with the addition of water only.

Specification

The following rooms shall have all ornamental castings, as indicated on drawings, cast in CASTACOUSTIC Plaster as manufactured by R. Guastavino Company of New York and Boston. CASTACOUSTIC Plaster shall be mixed in strict accordance with the manufacturer’s directions. The plasterer shall submit a sample casting for the approval of the architect. All cast work shall be set accurately and straight. Reinforcing and backing shall be used as would be required for the best type of ordinary ornamental plaster work.

REPRESENTATIVE LIST OF AKOUSTOLITH PLASTER INSTALLATIONS

Graduate School, Yale University, New Haven, Conn., James Gamble Rogers, Architect.
Harvard University, Cambridge, Mass., more than 17 buildings since 1925, including Lowell, Dunster, Eliot, Leverett and Adams Houses, Physics Laboratory, Faculty Club and Biology Building, Coolidge, Shepley, Bulfinch & Abbott, Architects.

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AKOUSTOLITH PLASTER

GENERAL INFORMATION

DESCRIPTION: AKOUSTOLITH PLASTER is a granular, porous, lightweight, masonry sound-absorbing material. It is both non-combustible and washable. It is not weakened or damaged by moisture.

APPEARANCE: The texture, on account of the structure of the plaster, is of necessity similar to that of sand-lime, but the general surface appearance may be varied as desired.

COLOR: In its natural color AKOUSTOLITH is a very light grey, almost white. It can be colored to any shade by the use of various colors added by the plasterer.

PAINTING: Painting after the installation can be done either by the brush or spray method. Almost any kind of paint having the consistency of a light oil varnish is satisfactory. Special paints for this purpose are on the market. We urge that the services of our organization be utilized in advising paint and application before proceeding with this work in order to ensure that the acoustic properties of AKOUSTOLITH are not impaired. Further information will be furnished on request.

ACOUSTIC PROPERTIES: AKOUSTOLITH PLASTER has been tested at the U.S. Bureau of Standards, Washington, D.C., and at other laboratories. The results of these tests together with actual installations prove this material to be superior to any other plaster for this purpose. The high efficiency of AKOUSTOLITH is due in part to the special system of application described in this circular under the heading, "Directions."

Note: We do not recommend that AKOUSTOLITH PLASTER be used for other than plain surfaces. Mouldings or ornamental work can be done in Acoustic Casting Plaster. Information on this material will be sent upon request.

COVERING CAPACITY: Applied 1/2" thick in one coat, one ton of AKOUSTOLITH PLASTER will cover approximately 100 square yards. Applied 1/2" thick, one ton will cover approximately 165 square yards.

LABOR: On ceilings the average plasterer can apply 3 to 3 1/2 square yards of AKOUSTOLITH PLASTER per hour. On walls, this work goes faster.

SALES DISTRIBUTION: AKOUSTOLITH PLASTER is sold direct to the plastering contractor by the factory, Chicago, Ill., and through jobbers and dealers. The retail price varies in different parts of the country from 75 cents to $1 per square yard. It is shipped in 25 lb. or 100 lb. bags, with the addition of water only.

SERVICING: It is the practice of the R. G. Donovan Co. to send a representative to the building to supervise the starting of every installation of AKOUSTOLITH PLASTER. At least one week's advance notice is usually required.

SPECIFICATIONS

FOR NEW BUILDINGS: Where AKOUSTOLITH PLASTER is to be applied on solid walls, concrete slab, hollow block partitions, or wire lath, the usual heavy scratch coat shall be applied, thoroughly well-troweled.

The base coats may be composited of either a 1:1:6 Portland cement, lime, or plaster. The surface on which the binder coat is to be applied shall be thoroughly smoothed to provide a proper bond.

When the scratch coat (or brown coat, if used) is properly set but still somewhat moist, apply a 1:2 binder coat composed of a 1:1 mixture by volume of lime and sand over the 1:1 scratch coat. This binder coat shall be followed immediately with one of the manufacturer's directions.

Where the scratch coat (and brown coat, if used) is composed of Portland cement plaster, the binder coat shall contain 1/2 part Portland cement, 1 part sand and 1/8 part Hydrated Lime by volume. Neither the binder coat nor AKOUSTOLITH PLASTER shall be applied until the base coats have thoroughly dried and obtained their full shrinkage. The base coat shall be wetted and allowed to set, but not to dry off completely, before applying the binder coat. After the binder coat has dried and taken all the necessary amount of moisture, apply the AKOUSTOLITH PLASTER to the binder coat to the thickness desired. The AKOUSTOLITH PLASTER shall be applied in a manner similar to that used for ordinary clay plaster, using the same tools and techniques.

OVER SWIMMING POOLS: Where AKOUSTOLITH PLASTER is to be applied on walls or ceilings exposed to continuous dampness or over swimming pools, the base coats shall be composed of Portland cement and applied in accordance with the standard specifications of the Portland Cement Association.

The binder coat shall be of the following proportions by weight: 1/3 part Portland cement, 1 part sand, 1/5 part Hydrated Lime. (Approximately 1/4 part Portland cement, 1 part sand, 1/5 part powdered Hydrated Lime.) Apply the binder coat 1/2" in thickness and follow immediately with one coat of AKOUSTOLITH PLASTER 1/2" in thickness.

FOR OLD BUILDINGS: The surfaces to be plastered with AKOUSTOLITH SOUND-ABSORBING PLASTER shall be hauled to remove the old finish coat of plaster, leaving the base coat exposed. The ceiling shall then be thoroughly wet to stop most of the suction.

Add the 1 1/2" binder coat as stated above and follow immediately with the AKOUSTOLITH PLASTER the same to be applied in strict accordance with the manufacturer's directions.

DIRECTIONS

HOW TO MIX AKOUSTOLITH PLASTER

Add only 1.5 gallons (15 quarts) of clean water to each sack of AKOUSTOLITH PLASTER. When so mixed AKOUSTOLITH PLASTER is a "dry" mix. This is necessary for its highest efficiency. The use of more than the specified amount of water will lower the acoustical efficiency and reduce the covering capacity.

AKOUSTOLITH PLASTER should be mixed with clean tools in a clean water-tight mortar box.

HOW TO APPLY AKOUSTOLITH PLASTER

FIRST: If necessary wet the base coat so that the binder coat will remain soft and sticky during the application of AKOUSTOLITH PLASTER.

SECOND: Apply a binder coat 1/2" thick of a rich mixture of hydrated lime and sand. (About equal parts by volume of powdered hydrated lime and sand will make such a mix.) Binder coat to be used against Portland cement base coats shall be of the following proportions by volume: 1/3 part Portland cement, 1 part sand, 1/5 part powdered Hydrated Lime.

THIRD: While the binder coat is still SOFT AND STICKY apply full 1/2" AKOUSTOLITH PLASTER in one coat with the ordinary steel trowel pressing the AKOUSTOLITH into the soft binder coat. Continue in one direction toward the plasterer already applied. AKOUSTOLITH PLASTER must be left open and porous—avoid excessive trowelling.

NO RETEMPERING: AKOUSTOLITH PLASTER contains Portland cement, and therefore, must not be re-tempered.

AVOID FAST DRYING as this reduces the strength of AKOUSTOLITH PLASTER.

*It is preferable to wet the base coat too much rather than too little to retain soft binder coat and insure slow set and drying of AKOUSTOLITH PLASTER. Should base coat be too wet it will be greatly apparent as the binder coat will not set.
Johns-Manville Company

H. W. JOHNS-MANVILLE CO.
Cork Tile and Akoustikos Felt
NEW YORK AND EVERY LARGE CITY
SEE BRANCH ADDRESSES IN OUR CATALOGUE IN ROOFING SECTION

Products and Services.
For complete list of J-M Building Materials, see our catalogue in Roofing Section.

J-M Pure Cork Floor Tile.
An ideal flooring for banks, libraries, theatres, churches, schools, clubs, residences, and many other types of buildings. It is also used on stairways, ramps, clerestories, and aisles, floors of yachts and steamers, and in restaurants and other places where it is essential to have a flooring that will not slip.

The wearing surface of J-M Pure Cork Tile is made of clear, selected cork shavings, while the body is of a coarse granulation of same material. Cork for each individual tile is placed in a closed steel mold and compressed to a small fraction of its original volume under tremendous hydraulic pressure. During this process the cork is heated to a temperature that liquefies the natural gum and bonds the particles into a homogeneous mass. The result is a solid block of cork containing no other natural constituents. No cement or foreign substance is used.

How Applied—J-M Pure Cork Tile is set in special waterproof cement that holds equally well on a wood, metal or cement backing. It is customary to leave the tile without artificial finish, but if desired, a very attractive finish can be obtained by applying any standard floor wax.

Advantages—J-M Pure Cork Tile outshines all other floor coverings. It will even outwear a hardwood floor. Our method of compressing and baling each tile separately gives it a harder and more uniform surface than is possible by manufacturing tile two or more at a time and afterwards cutting them apart.

It is impervious to the tread as a heavy carpet, and its resilience minimizes footlessness and fatigue.

J-M Pure Cork Tile is highly fire-resisting. It will retard the spread of flames from one floor or room to another.

Because of its efficiency as an insulator, it helps to keep rooms cooler in summer and warmer in winter. Being a non-conductor of electricity, it makes a valuable flooring around switchboards or wherever electrical apparatus is in use.

The method of laying this flooring hermetically-seals all joints and renders it impossible for germs or filth of any kind to get into cracks orunder tiling. Grease and liquids do not stain it. It can be washed with warm water or a diluted disinfectant without injury, and being non-absorbent, is clean and sanitary.

Decorative Application—J-M Pure Cork Tile produces an especially rich and warm effect in all interior decorations. It can be used successfully in any decorative scheme, as there is no limit to the variety of patterns and shapes that can be produced. A large number of designs used in parquetry are available in this tiling.

The surface of J-M Pure Cork Tile is totally different from the grinding effect found in various woods used for interior decoration. Yet it harmonizes perfectly with any of them. When used for wainscoting, particularly artistic effects are obtainable, as tiling takes a varnish finish of any desired tone.

Colors—J-M Pure Cork Tile is supplied in light, medium and dark colors. The dark tiling approximates Indiana Walnut, while the light is similar to Syrian Olive. These different colors are obtained by simply changing the temperatures of the baking ovens. No artificial coloring is used.

The slight variation in the coloring of these tiles, in conjunction with their veined and mottled appearance, gives a delicately shaded effect that is much more pleasing than the sharp alternation of color found in ordinary tiling.

Sizes—J-M Pure Cork Tile is furnished in the following standard sizes:

Border strips, random lengths 12", 6", 4", 3" and 2" wide.
Fields, squares 12" x 12", 6" x 6", 4" x 4" and 3" x 3".
Blocks 12" x 6", 12" x 4" and 12" x 3".
Special sizes furnished if desired.

J-M Akoustikos Felt for Correction of Acoustical Defects.
We are prepared to execute contracts for the correction of defective acoustical conditions in all types of public and municipal buildings—churches, theaters, court houses, schools, colleges, hotels, offices, etc. In furnishing such contracts we are rarely compelled to make any radical changes in general architectural details. Where it has been found necessary to make slight modifications, this has been done in such a manner as not to impair the general appearance of the interior.

Our method of treatment consists of applying J-M Akoustikos Felt of a proper thickness to such portions of interior surfaces as is found necessary to reduce excessive reverberation to a degree consistent with distinct hearing and yet preserve sufficient intensity of sound. This felt is covered and protected with a membrane which can be decorated in any desired manner so as to reproduce the original appearance of the surface treated.

Our Acoustical Department is in charge of experts who have made a scientific study of architectural acoustics, and their knowledge is supplemented by the practical experience gained in the technique of applying the necessary corrective materials.

Swede's Catalogue

145
JOHNS-MANVILLE ACOUSTICAL TREATMENT AND SOUND ISOLATION

Johns-Manville is prepared to supply a solution to any problem involving the control of sound in buildings. This includes the quieting of offices, banking rooms, stenographic rooms, bookkeeping departments, telephone rooms, school and hospital corridors, etc.; the attaining of good hearing conditions in theatres, auditoriums, churches, lecture and concert halls, courtrooms, etc., and the isolation of sound so that it will not be transmitted through walls, floors or ceiling from one room to another. Problems involving sound isolation require an entirely different method of treatment, in no sense interchangeable with the methods employed in acoustical correction. With the increasing number of large buildings, housing scores of various activities, the necessity for adequate sound insulation between rooms and floors becomes increasingly apparent. Johns-Manville also presents the J-M (formerly Stevens) System of Sound Isolation as an addition to this service on sound control. Available sizes of units and other characteristics of all Johns-Manville acoustical materials are tabulated on page 5.

Exact calculation can be made of the degree of quieting possible to obtain and the results measured and checked with accurate measuring apparatus. Performance reports on Johns-Manville installations are available showing improvement effected by this quieting treatment, the increased efficiency of employees and the results in savings in dollars and cents.

Johns-Manville has had more than twenty years' experience in acoustical work, dating from the retaining of the late Wallace Clement Sabine of Harvard University as consultant. During this period Johns-Manville Engineers employing Johns-Manville acoustical materials have successfully undertaken problems of every type involving reverberation, echo, distortion, resonance, faulty distribution, etc.

The materials employed have been developed for specific purposes. There has been no adapting or making over of products designed for other uses in order that they might be exploited as an acoustical material. Where a need for an acoustical treatment having certain characteristics of finish or sound absorption has developed, a search has been made until such a material has been found or invented. As the science of acoustics has progressed, the Johns-Manville line has been improved to keep abreast with demand. The new and exciting acoustical requirements of sound film and radio broadcasting studios and talking movie theatres have been met.

Co-operation of our Acoustical Engineers with the architect has always been the keynote of J-M Acoustical Service. Particularly in the sketch stage of design is such co-operation desirable, as early study generally makes possible the attainment of ideal rather than simply acceptable acoustics. In the case of existing structures, J-M Acoustical Treatment can be applied to interiors with little or no mutilation of their architectural lines and with no visible alteration in shape or size.

Adaptability

One of the outstanding advantages of J-M Acoustical Materials is their adaptability to practically any architectural requirement. Large unbroken areas, panels, plane, curved or offered surfaces may be treated. The resulting surfaces may be continuous similar to a plaster treatment or jointed as where tile are used. Square or rectangular tiles applicable in ashlarp, herringbone, basket weave, etc., patterns are procurable.

Every material in the J-M Line is permanent, sanitary and readily cleaned. With few exceptions they can be washed with soap and water and repainted.

Color and Texture

The decorative effects procurable in the use of J-M Acoustical Materials, both in color and texture, are almost unlimited. The natural and interesting textures of the materials themselves may be utilized or their surfaces may be treated to produce the effects obtained through the use of the more familiar forms of interior finish.

Solid colors, patterns, stenciled decorations, special border effects, wood graining, etc., are attainable. Almost any textural effect obtainable in plaster as well as wood and metal treatments is possible. Johns-Manville acoustical materials make their own contribution to the decorative scheme.

Efficiency

In sound absorbing efficiency these materials are equally pre-eminent. There is a material for any degree of absorption required, from Sanacoustic Tile, with the Manville has conducted a great deal of research on the variation of absorption with frequency, so that each J-M Treatment is especially adapted to the class of sound sources with which it has to deal.

Fire Resistance

Another important characteristic of J-M Acoustical Materials is their resistance to fire. Each one has been suit, J-M acoustical materials are so nearly incombustible that they are accepted for fireproof buildings by
Sanacoustic Tile

Sanacoustic Tile is a sound-absorbing interior finish that consists of a perforated metal container utilizing J-M Banroc Wood as the sound-absorbing element. The tile are made in three standard styles and sizes, permitting a great variety of patterns. They are supported by copper bearing steel furring T’s which may be economically fastened to any type of structural support. When installed in buildings during the course of erection, metal lath and plaster may be omitted.

The surface of J-M Sanacoustic Tile is finished in baked enamel which gives it a very high light reflecting value and a sanitary surface which may be easily cleaned with a damp cloth or sponge. It may be repainted or decorated without impairing its sound-absorbing efficiency. Any decorating media may be used to secure any desired effect.

Sanacoustic Tile is also available in pre-decorated form, nine standard designs being available, including types appropriate for any of the most commonly used styles of interior decoration.

It is particularly adapted to offices, hospitals, restaurants and schools. Under excessive humidity conditions, such as are encountered in swimming pools, kitchens and sterilizing rooms, the tile and supporting members are made of aluminum, and under these conditions there is absolutely no danger of corrosion either of the tile or the sound-absorbing element.

Sanacoustic Tile finishes may also be obtained in flat perforated sheets known as Sanacoustic Panels. They may be obtained 30 to 48 in. in width, up to 14 ft. long. By this means it is possible to use various of the new commercial metals and alloys, or to obtain panel effects with imitation wood veneering, etc.

Sanacoustic Holorib for Interiors

This product utilizes the large unit possibilities of a perforated Holorib metal deck plus the highly efficient sound-absorbing qualities of rock wool, providing all the exceptional qualities of Sanacoustic Tile in large units with a corresponding saving in cost of installation. The product is obtainable in lengths up to 10 ft. and the finished appearance is that provided by long narrow panels rather than square or rectangular tiles.

Sanacoustic Holorib for Roofs

This product is an adaptation of the familiar steel roof deck unit wherein extraordinarily high sound absorption characteristics are added to the well established advantages of this type of construction. It utilizes the perforated metal feature of J-M Sanacoustic Tile on the exposed interior surface, filling of J-M Rock Cork as the sound-absorbing element, two layers of J-M Insulating Board as heat and cold insulation in addition to that provided by the Rock Cork, the whole being weatherproofed on the exterior surface with J-M Asbestos Built-up Roofing. It may be used wherever steel roof deck construction is applicable. It is a combination of materials which have individually and successfully proven their worth over a period of time.

Rockoustic Type A

The name "Rockoustic" describes the material perfectly. This newest addition to the Johns-Manville line of acoustical materials is an acoustical tile composed of a mineral aggregate. In the process of manufacture
it is compressed into a block sufficiently rigid to be easily installed, yet with enough porosity to make it a highly absorptive acoustical finish.

Rocksiltile Type A presents a pleasing variegated surface and can be obtained in a variety of colors. It is cemented in place with a special Johns-Manville Cement. It is manufactured in several different sizes and can be adapted to a wide variety of patterns and designs.

Nashkote

Nashkote is a system of building up a sound-absorbing interior finish on the job. It consists in the application of a highly efficient acoustical felt to an ordinary structural backing, and the finishing of the exposed surface of the felt with various types of finishes, depending upon the architectural requirements. Nashkote may be applied over areas of any size without the necessity of paneling or coffering. It is a most adaptable type of sound-absorbing interior finish.

Nashkote Type A—In this type a fabric of sheer muslin is cemented to the surface of the felt and painted with a washable oil paint. It has the finished appearance of a painted hard wall plaster surface upon which any type of decoration or murals may be painted. After this the surface is perforated by mechanical means to provide any predetermined acoustical efficiency without loss to the decorative value of the finish.

Nashkote Type B—In Type B the finished fabric cemented to the surface of the felt is an oicloth, perforated in a variety of interesting patterns. The perforations do not detract from the appearance, but rather add a fine feeling of texture. The surface may be washed or decorated without an appreciable effect upon the sound-absorbing efficiency of the material.

Nashkote Type C—Utilizes a white surfaced felt in which the decoration where desired is applied directly to the surface of the felt. It is excellent for high ceilings in churches, armories and auditoriums where sound-absorbing efficiency, economy and decorative value demand equal consideration.

Nashkote Type F—In this type the finished fabric consists of a pre-decorated membrane such as dyed burlap, brocades, cretonnes, Japanese grass cloth or awning cloth. These fabrics may be applied as competently upon the acoustical felt as on a plastered surface.

Nashkote A1S

Nashkote A1S—A sheer muslin fabric is cemented to the surface of the felt and painted with a sand and oil or sawdust and oil paint to simulate a sand finished plaster surface. This type of finish is employed to obtain even stone effects and interesting swirl textures.

Nashtile

Nashtile consists of specially prepared asbestos and hair felt, punched and shaped to form semi-rigid tile in standard sizes with or without beveled edges. The surface of the tile is finished with a mineral aggregate cemented directly to the felt with a waterproof cement. Color may be obtained either through the natural color of the aggregate or the surface can be finished with lacquer. The tile may be laid in cement against any kind of a structural backing, to form an unlimited variety of patterns. The surface of the tile may be washed or scrubbed or relacquered by the brush or spray method. The sound-absorbing efficiency is very high.

Short Form Specification for Furnishing and Applying Johns-Manville Acoustical Treatment

[Omit the following paragraphs if no mouldings are to be used]

The furnishing and installing of mouldings adjoining the acoustical treatment shall be (State whether "included" or "excluded" See Note 2).

Work Not Included—The following work will be furnished and installed as specified under other divisions of the specification which is called for therein. (See Note 3) (The paragraphs which do not apply to the job at hand are to be omitted.)
(a) Unless otherwise specified, the special decoration on all exposed surfaces of the acoustical treatment.

(b) Unless otherwise specified, all moldings adjoining the acoustical treatment.

(c) Prepare concrete surfaces to receive the Nashbolt, oak coat of Portland cement and sand, brought to a true level.

(d) Prepare tile or masonry surfaces to receive Nashbolt, plaster brought to a true level.

(e) Prepare furred ceiling surfaces to receive Nashbolt, scratch and brown coats of plaster, brought to a true level and finished reasonably smooth. (A white putty coat may be substituted with venting surfaces to receive the Sanaacoustic finishes, and installed hot rolled steel plasterer's channels or angles, rigidly and securely to a uniform surface, at least 1 ft. above the finished ceiling surface. Such channels or angles shall be placed not to exceed 4 ft. centers. Similar beams and other projecting surfaces which are parallel to the direction of the channels or angles.

(f) Prepare wood framing to receive Nashbolt, Nashbolt or Rockonstile types of treatment by spacing members not to exceed 18 in. centers.

(g) Set all electrical outlet boxes flush with the finish surfaces of the acoustical treatment.

Materials and Workmanship—All work under this Specification and Contract shall be executed in strict conformity with the "Standard Specification of JOHN S. MANVILLE for the Furnishing and Applying of Acoustical Treatment," which Standard Specification is hereby declared and made a part of this specification with the same force and effect as if written herein in full.

The work shall be done by JOHNS-MANVILLE or an authorized and approved Contractor for JOHNS-MANVILLE Acoustical Materials.

Type of Acoustical Treatment—Acoustical Treatment shall be .................. (State type designation, thickness and, in the case of tile, size and standard or special color of units, design to be followed in applying, and whether square or beveled edge tile are desired. See note 4.)

Note 1: Acoustical or sound-absorbing materials vary in sound-absorbing efficiency with variations in the physical properties of the material, and the characteristic of the finished surface. The Architect or Engineer should confer with the J-M Acoustical Engineer; determine the type of sound-absorbing material best adapted, from an architectural and decorative standpoint, for the project; have an analysis made showing the unit and number of square feet of surface, the sound-absorbing power, the sound absorbability, and the material selected in order to obtain the results desired; and indicate the material and absorbability, as well as the absorption coefficient and absorption coefficient of the material, also the surface area to be treated.

Note 2: All ceiling tile, employing a sound-absorbing element 2 in. or greater in thickness is to be used, consult the J-M Acoustical Engineer for special specifications.

Note 3: The decortication of the acoustical treatment where other than the standard finish is desired may be done by other contractors. In this event the Architect or Engineer should, in conformity with the J-M Acoustical Engineer, determine the type of decoration best adapted for the purpose and specify the medium to be used.

The J-M System of Sound Isolation employs a series of patented isolators. These devices are placed between the exposed face of the structure and the substructure to prevent vibrations from being transmitted. The shock absorbing action of these isolators is usually aided by a layer of sound-absorbing material. This system provides a series of materials having different densities, each of which offers new resistance to the passage of the waves.

Among its more common applications may be mentioned the insulation of ballrooms, kitchens and lavatories in hotels, bowling alleys in clubs or combination theater buildings, lodging buildings, apartment buildings, broadcasting studios, etc.

Johns-Manville System of Sound Isolation (Formerly Stevens System of Sound Proofing)—Sound isolation is the process of preventing sounds generated in one part of a building from passing to another part through partitions or other members of the structure. Sound waves either pass directly through these structures or set them in vibration. In the latter case the vibrating structure reproduces the sound on the opposite side. With this in mind it becomes obvious that one of the two things must be done to prevent sound transmission. Either the structure must be built so massively that the sound waves cannot set it into vibration, or else the surface must be so isolated from the substructure that it is free to vibrate of itself without transmitting the vibrations.
Four of the largest groups of broadcasting studios in the country are built throughout with Johns-Manville sound insulating walls, floors and ceilings. J-M isolators consist of steel "chairs" or clamps lined with hair felt. Different designs are used for the various floor, wall and ceiling constructions. Special combinations are designed for use under machinery to prevent the vibration from being transmitted to the supporting structure. The system is flexible. It has been used for more than a decade in all types of buildings with notable success, including the most modern fireproof constructions.

Specifications furnished on application.
Explaining Macoustic

The secret of ideal acoustical quality—or good hearing—in any interior is the proper control of sound or sound reflection within that interior. Sound waves must be controlled, diffused or absorbed in such a manner as to eliminate excessive resonance and to reduce the period of reverberation, or the prolongation of sound, to its proper value.

**Acceptable Limits of Reverberation**

<table>
<thead>
<tr>
<th>Volume of room in cubic feet</th>
<th>Time in seconds</th>
<th>Half Maximum audience audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000</td>
<td>0.9-1.2</td>
<td>0.6-0.8</td>
</tr>
<tr>
<td>21,000</td>
<td>1.0-1.3</td>
<td>0.8-1.1</td>
</tr>
<tr>
<td>19,000</td>
<td>1.2-1.5</td>
<td>0.9-1.5</td>
</tr>
<tr>
<td>100,000</td>
<td>1.5-1.8</td>
<td>1.2-1.5</td>
</tr>
<tr>
<td>200,000</td>
<td>1.8-2.0</td>
<td>1.4-1.7</td>
</tr>
<tr>
<td>400,000</td>
<td>2.1-2.3</td>
<td>1.7-2.0</td>
</tr>
<tr>
<td>600,000</td>
<td>2.3-2.6</td>
<td>1.8-2.2</td>
</tr>
<tr>
<td>800,000</td>
<td>2.5-2.8</td>
<td>1.9-2.3</td>
</tr>
<tr>
<td>1,000,000</td>
<td>2.6-2.9</td>
<td>2.1-2.5</td>
</tr>
</tbody>
</table>

U. S. Bureau of Standards—Bulletin 300

The period of reverberation may be considered the fundamental measure of good hearing condition, yet other important factors, which directly or indirectly affect the final acoustical result, must be carefully analyzed.

A detailed analysis, for example, of the section and plan drawings of a theater, church or auditorium interior must take into full consideration the general proportions and relative values of all dimensions. The analysis must consider the character of ceiling and wall surfaces; the shapes, location and effects of curved areas; the physical characteristics of all exposed surfaces of ceiling, walls, floors, seats, pews, furniture, draperies and floor coverings; the size and distribution of audience under varying operating conditions; the floor pitch, proscenium and stage development; number and character or sound sources and other important factors.

Any or each of these factors may have an important bearing on the development of clear and distinct hearing conditions uniformly throughout such an interior. It may be necessary to minimize distracting sound reflections from ceilings, upper side walls or from distant rear wall areas, because these secondary sounds travel over paths which are many feet longer than the direct distance between the original sound source and the auditor’s ears, causing a lapse of a split second of time and a resulting confusion of sounds in many parts of the room.

Certain resonance must be retained to preserve tone volume and quality throughout an interior. This involves, as a rule, the treatment of properly determined areas with a material which will reduce reflected sounds to a desirable degree; a material of such a nature as to permit its use over extensive rather than restricted areas, with resultant increased uniformity of effectiveness.

The following is taken from a letter of a recognized and impartial authority on acoustics:

"A large area of low absorbing material is acoustically equivalent to a smaller area of more highly absorbing material, and where a sufficient area is available, it may often be advisable to use the material of lower absorption from considerations of greater acoustic uniformity. It is to be remembered that excessive absorption is as undesirable as a deficiency."

Acoustical treatment must provide a uniform degree of good hearing under varying audience conditions; an average-sized audience must hear as distinctly as a full-sized audience. Such a treatment must be low in cost as well as simple and inexpensive to apply. It must be permanent—a building material—and must become an integral part of the structure. It must be fireproof and rat and vermin proof,
Explaining Macoustic (Continued)

This extraordinary acoustical value is the direct result of properly coordinated triple-acting mechanical-aero-chemical processes.

No material can absorb more than a certain percentage of the sound reaching it, so obviously, the remaining free sound must be reflected or returned to the room. Since it is a well-known physical law that the angle of reflection is equal to the angle of incidence, then sounds are reflected from a smooth surface along a definite prescribed path, which tends to produce areas of serious sound disturbance in certain sections of the room. Not so, however, with Macoustic. Its distinctive texture produces a diffusion or scattering of reflected sounds which reinforce rather than conflict with the successive sound waves that are being emitted from the sound source. Thus Macoustic has a variable dual action combined with other unique and distinctive features, not possessed by any other product. Although the fundamental and basic formula of Macoustic has never been changed it has been constantly improved and refined until today Macoustic is the most practical and economical acoustical treatment of proven merit on the market.

U. S. Bureau of Standards Tests

Recent sound absorption tests of Macoustic in the new reverberation room of the sound laboratory at the Bureau of Standards, Washington, definitely indicate the exceptional efficiency of our product.

The results obtained are as follows:

<table>
<thead>
<tr>
<th>Frequency—Cycles per Second</th>
<th>512</th>
<th>1024</th>
<th>2048</th>
<th>4096</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floated Texture</td>
<td>.19</td>
<td>.21</td>
<td>.26</td>
<td>.27</td>
</tr>
<tr>
<td>Stippled Texture, Fiber Brush</td>
<td>.22</td>
<td>.37</td>
<td>.41</td>
<td>.55</td>
</tr>
<tr>
<td>Stippled Texture, Pin Brush</td>
<td>.31</td>
<td>.39</td>
<td>.58</td>
<td>.65</td>
</tr>
</tbody>
</table>

The above results are the average of four separate determinations.
Engineering Service

No two interiors are alike, therefore the acoustical problem is different in each case and must be analyzed accordingly. Many factors enter to affect the acoustical quality of a church, theater or auditorium where audiences are variable and distances are great. A different problem is encountered in classrooms, offices, cafeterias, libraries and working spaces and corridors. New conditions enter which are of vital importance in the determination of the logical method of acoustical treatment to obtain desired results. The illustrations below show how various problems are handled.

Acoustics is an exact science. Ours is a highly specialized business, requiring the attention of technically-trained men. Our Engineering Service is as widely and as favorably known as our product. This service is an essential part of our Macoustic sales, because neither we nor our clients can afford to guess at results. An extensive and intelligent analysis pre-determines results. This analysis is the basis of our detailed engineering report which describes in a clear and concise manner the acoustical condition of an interior with and without acoustical treatment, whether treatment is necessary, and if so, where Macoustic should be applied to obtain the best results, for the least cost and for decorative effects in complete harmony with the architect's design.

Our Sales Engineer in your territory will gladly transmit your drawings to our Engineering Department in Cleveland, where our analysis will be expedited so that our complete report, including cost figures, can be delivered to you promptly. Or if you prefer you may send them direct to our Home office in the Union Trust Building, Cleveland, Ohio.

There is no charge whatever for this advisory service, nor any obligation. If unforeseen reasons should defeat your intention to use Macoustic, your good will is our only reward for the benefits of our counsel.

Macoustic Service has eliminated guess-work and dispelled much of the mystery that formerly surrounded this subject of Acoustics.
Macoustic ~“Goes on Like Plaster”

MACOSTIC is a plastic material applied like plaster. Thus the acoustical treatment takes the place of the finish coat of ordinary plaster and becomes an integral, permanent part of the building. When sound is allowed to travel unmolested through the air you get purity and clarity of tone. But when these sound waves are confined to interiors of rooms and buildings they are deflected, amplified or otherwise affected by contours and building materials with which they come in contact. Thus building materials become an important factor in acoustical science. The ideal treatment is then, that which uses a building material having acoustical properties.

Macoustic is troweled or floated on to an average thickness of one-half inch. It is applied over the usual “brown coat” of hard plaster. No specially trained craftsmen are required to apply Macoustic. It is applied by the ordinary plasterer. Thus exorbitant labor charges are avoided, and a separate acoustical contract eliminated.

Macoustic is delivered in a dry state and requires only mixing with water to be ready for application. Instructions for plasterers are furnished which cover the practical application of Macoustic in full detail.

Baltimore, Md.
January 12, 1929.

MACOSTIC ENGINEERING CO., INC.,
Union Trust Bldg.,
Cleveland, Ohio.

Dear Sir:

Replying to yours of the 11th inst. beg to say that we found the Macoustic, which we applied in the Holy Rosary Church, just as you represented it.

Our plasterers advised us that Macoustic worked as easily as white finishing.

Wishing you the best of success, and trusting you that if any acoustic problems or jobs come up before us we shall call upon you, we are,

Yours very truly,

John H. Hampshire, Inc.,
R. M. TAGG, Secretary-Treasurer.

Chicago, Ill.
March 25, 1929.

RE: LOEW'S THEATRE—AKRON, OHIO.
MACOSTIC ENGINEERING CO., INC.,
Union Trust Building,
Cleveland, Ohio.

Gentlemen:

Your Macoustic material has made quite an impression on our organization on the above job, as it was the first time that we have come in contact with it.

We have used other plastic acoustical materials, but we feel that from a plasters’ standpoint Macoustic is the easiest material to handle, both in mixing and application.

We also appreciate the service your company rendered; particularly want to thank Mr. Mowbray for the close attention and instructions he gave to our foreman.

Assuring you our cooperation at all times, we are,

Very truly yours,

Architectural Decorating Co.,
W. F. MCKINNON,
Vice-President.
MACOUSTIC, because of its plastic nature, is susceptible to a wide variation of architectural and decorative treatment. While Macoustic should preferably be finished with a rough surface it can be stippled to approximate a smooth surface. Its plastic consistency permits of any type of texture finish. A very pleasing effect can be obtained with this material in its rugged finish contrasted with hard plaster, ornamentations, mouldings, cornice, pilasters and beams.

Macoustic is adapted for use over curved and intricate areas as well as on flat surfaces. It does not conflict with the extensive use of hard plaster ornamentation, but on the other hand, combines with or contrasts ideally with such ornamental treatment. Macoustic can be cast or moulded into ornamental shapes or designs.

The natural color of Macoustic is neutral gray-white and while architects often prefer this natural shade, it may be given other color treatment.

Macoustic is available in a range of standard colors integrally mixed by our special mill tinting process, or Macoustic can be decorated after application by use of our special Macoustint. Macoustic can be cleaned, retextured and redecorated. These are distinctive and exclusive Macoustic features.
Proof of Macoustic Success

The Cleveland Public Auditorium

The Cleveland Public Auditorium since 1921 has been recognized not only as the country's largest plastered interior but also as the most successful large interior acoustically. Due to Macoustic design and Macoustic treatment throughout, every person in the audience (seating capacity, 13,000 people) can hear perfectly under every operating condition. It is only logical, therefore, that Macoustic has been exclusively used in the two new additions (see letter page 14) to assure proper hearing conditions in the Music Hall, Guild Theater, Ball Room and office spaces.

National Broadcasting Studios

The engineers of The National Broadcasting Company with their background of years of practical experience in sound problems, and with the combined facilities of their organization—the Radio Corporation of America, American Telephone and Telegraph Co., General Electric Co., and Westinghouse Electric Co.—made a thorough investigation of all types of acoustical treatment, for the twelve studios in the new National Broadcasting Building on Fifth Avenue, New York City. No expense or effort was spared to obtain equipment and conditions to produce the highest possible standards in all programs. No single factor had a more direct bearing on this result that the acoustical quality of each studio.

Macoustic treatment was chosen as the logical solution of their problem, and the nationally acclaimed perfection of the National Broadcasting Company's programs from WEAF and WJZ over the Red and Blue Network is the greatest testimonial ever given to any acoustical product.

As further evidence of the outstanding performance of Macoustic treatment—proven by actual operating conditions in the New York studios—Macoustic treatment was subsequently specified outright and installed in the National Broadcasting Company's studios in Washington, D. C., San Francisco, Cal., and in Chicago, Ill. Photograph of the arrangement of the N. B. C. Studios is shown on Page 8.

John Hancock Building

Three acres of Macoustic treatment were installed in the Home Office Building of The John Hancock Mutual Life Insurance Company, one of the largest acoustical contracts ever awarded for this type of work.

Macoustic was chosen for this building after competitive tests were made of the leading acoustical treatments. For test purposes a large typical room was allotted to each of the various competitive treatments and complete installations were made. After a rigid investigation and comparison by competent authorities, Macoustic was exclusively specified and installed throughout the entire office areas. This choice was made not only on acoustical effectiveness, but also on permanence, low cost of maintenance, freedom from fire and vermin hazards, freedom from disintegration and dusting, maximum light reflection and pleasing appearance.
Where Macoustic Should Be Used

"No Public Building whether Theatre, Auditorium, Church or School can be an Acoustical Failure and a Financial Success"

The low cost of Macoustic, its simple method of application, and its broad adaptability have extended the field of acoustical treatment to include many types of interiors hitherto barred because of high cost. Macoustic Treatment is highly effective in—

**Churches**

Good acoustics, providing a clear and distinct condition of hearing in every section of the interior, is of prime importance.

**Theatres**

The modern theater with its large spans, high ceilings, distant reflecting surfaces, extensive use of hard plaster ornamentation, talking "movies," large orchestras, powerful organs and varied programs demands a positive and uniform degree of good hearing under all audience conditions.

**Auditoriums**

Macoustic service and treatment assures correct acoustics and successful operation, reflected in Box Office receipts.

**Schools**

Macoustic treatment in classrooms and corridors, as well as in school auditoriums, eliminates nerve-racking noises, insuring increased attention and better efficiency of both teachers and pupils.

**Dining Rooms and Cafeterias**

How frequently a beautiful dining room or grill room, or an otherwise efficient cafeteria is rendered distracting and uninviting by the clatter of dishes and the hum of conversation. Eliminate this annoyance with Macoustic.

**Office Buildings**

Many interiors of modern office buildings are acoustically treated, at great expense, after occupancy because tenants demand quiet, workable offices free from distracting noises. Anticipate this need with Macoustic in original construction at low cost.

**Hospitals**

Macoustic treated private rooms, wards and corridors, as well as operating rooms, are quiet, sanitary and pleasing to the eye.

**Banks**

The clatter of typewriters, adding machines, and other mechanical equipment is not only distracting to the employees but offensive to the patrons.

**Court Rooms**

The proportionately large volume of court rooms and small average number of occupants combine to produce excessive resonance which interferes with quiet, dignity and clarity. Macoustic treatment on walls and ceilings will correct unsatisfactory hearing conditions.

**Club Houses and Locker Rooms**

Modern clubs are using Macoustic to reduce noise and to assure dignified and comfortable conditions.

**Department Stores**

Macoustic treated department stores are free from the hum and clatter and are inviting to patrons.
Macoustic Specification Data

When specifying Macoustic use the following:
Macoustic, manufactured by The Macoustic Engineering Company, Incorporated, Union Trust Building, Cleveland, Ohio, to be applied on all surfaces specified and recommended by the Manufacturer's Engineering Department, and in accordance with their standard specifications.

Macoustic is mixed with clean water and applied in the same manner as ordinary plaster, over the usual brown coat, and laid on to a depth of one-half inch. Produce specified surface texture finish.

Mixing and Application

Mixing Macoustic: Macoustic as delivered in bags is ready for mixing with clean water to the proper consistency. Use a liberal amount of water.

Macoustic must not be re-tempered. For this reason we recommend mixing small batches and applying promptly.

Caution: Be sure that mixing boxes, boards, hoes and tools are scraped and scrubbed clean and free from lime or gypsum plaster or other foreign material.

Application: Macoustic is applied in the same manner as ordinary plaster, using the steel trowel or wood float for laying on.

We recommend first the application of a light scratch coat of gypsum plaster in the usual manner. Then when the scratch coat has set, double with a light brown coat of gypsum. This brown coat to be scratched in all directions with a wood or wire scratcher. (Thus far the plastering operation is exactly the same as if the surface was to be finished in either hard or sand finish.)

Macoustic should preferably be applied within four to twelve hours after the application of the brown coat of gypsum plaster, when the brown coat is in a half-green condition. Should several days elapse between the application of the brown coat and the application of Macoustic, the gypsum coat must be thoroughly wet down before applying Macoustic, thus reducing the suction to the proper degree and allowing Macoustic to dry slowly and most effectively.

We require a uniform thickness of not less than ½" of Macoustic and recommend the following method of application: Lay on an initial layer of Macoustic approximately ¼" thick over a moderate area and then immediately double up with a Macoustic finish coat ½" thick.

By this method the initial coat of Macoustic will take a preliminary set and the finish coat may be given the desired or specified surface texture finish.

Macoustic, being of a fatty nature, is laid on faster and more easily than ordinary plaster.

Caution: Remove all plaster screeds or putty coat from the surfaces to which Macoustic is to be applied.

Surface Textures of Macoustic

We generally recommend a stippled finish and best results will be secured by using one man to lay on Macoustic and to follow up promptly with a second man to perform the stippling operation. Best results can be secured by the use of our special stippling brushes. The labor cost for this finish is no more than for a sand finish.

Macoustic may also be "pulled" with a trowel or manipulated by hand like ordinary plaster, if antique textures are desired.

Macoustic can also be marked off to represent stone.

Where Macoustic is to be applied over extensive wall or ceiling area, that particular entire panel or section should be run in and completed at only one operation. In other words, it is not advisable with Macoustic, any more than with any other surface finish, to break off in the middle of a panel at the end of a day's work, allow the material to dry over night, and then finish the panel the next morning. This precaution should be taken in order to avoid any possibility of a lap mark showing after the material has thoroughly dried out.

Caution: Oil paints must not be used on Macoustic.

We will gladly supply information relative to methods for decorating Macoustic.
Cost of Macoustic

IN COMPARISON with all other acoustical treatments, Macoustic effects a marked saving. The selection of this material by the City of Cleveland for its public auditorium saved the city over $100,000. Macoustic is sold to the plastering contractor and is applied in place of the ordinary finish coat of hard plaster. No separate acoustical contract is necessary. No specially trained craftsmen are needed. This eliminates a large item of expense. The cost of applying Macoustic is approximately the same as Sand Finish labor cost. Macoustic is the lowest cost material, per unit of absorption or per unit of area, on the market at the present time. One ton of Macoustic will cover a minimum of one hundred square yards.

Leading plastering Contractors everywhere endorse Macoustic. We have many letters testifying their satisfaction with our product, its simplicity and low cost of application, and its fascinating appeal to the man who actually applies it.

December 4th, 1927.

MACOSTIC ENGINEERING COMPANY, INC.,
Cleveland, Ohio.

Gentlemen:

In reply to your inquiry we are pleased to give you the following information.
The scale of wages for plasterers in the city of Cleveland is $11.00 per day, hod carriers, $7.00 per day. Basing an estimate on one laborer serving two and one-half plasterers, would make a labor cost per plasterer of $13.80. The average plasterer can finish one hundred yards of Macoustic per day, making a net cost of labor of 11.4¢ per square yard. In other words the cost of applying Macoustic is not more than for applying a coat of hard or sand finish.

We fully approve of the stiffing of the surface of Macoustic which you generally recommend. The special stiffling brush which you supply has a large area, and we find that one man can stiffle as fast as two men can lay on. This gives your material a very distinctive appearance.

We have done thousands of yards of this material and have kept very close record of the cost of application.

Trusting that the above information will be benefit to you, we are,

Very truly yours,

The Bagnall-Taylor Co.,
J. A. TAYLOR,
President.

JAT:AS

Chickering Hall
Los Angeles, Cal.
Meyer & Heller, Architects

Second Church Christ Scientist
Rochester, N. Y.
Gordon & Kailber, Architects

Board Room, Phillips Academy
Andover, Mass.
Chas. A. Platt, N. Y., Architect
Universal Endorsement

DETROIT HOSPITAL

MACOUSTIC ENGINEERING COMPANY, INC.
Cleveland, Ohio.

Gentlemen:

Replying to yours of the 24th,

1. of course, cannot pass as a judge of sound-deadening materials.

All I can say is that the acoustical condition which prevails in our auditorium and nurses' class rooms are quite favorable and thoroughly satisfactory to us. I have paid particular attention to the auditorium, and whether the crowd has been small or large, or whether the clothing has been starched uniform of nurses or the ordinary worn by the average audience, the sound conditions have been quite satisfactory.

Yours very truly,
Herman Kiefer Hospital,
GEO. E. PHILLIPS, Supt.

WINSTON-SALEM CHURCH

Mr. Hall Crooms, A. L. A., of Winston-Salem, N. C., says:

"As to the success of Macoustic Treatment in the Augsburg Lutheran Church, you may be interested to know that a sound test taken in the nave, shows a reverberation period which I consider to be perfect.

"Macoustic is very easy to apply, has a nice appearance and its decorative possibilities are practically unlimited. I have used the material in two buildings and hope to use same in the chapel at Fort Bragg, which is being designed in this office at this time."

INDIANAPOLIS BANK

MACOUSTIC ENGINEERING COMPANY, INC.
Union Trust Building,
Cleveland, Ohio.

Gentlemen:

Prior to the erection of our present building, the matter of acoustical treatment was the subject of considerable consideration on our part, as we fully realized that the constant jarring and clacking of typewriters, adding machines, noon-hour laterals, etc., in a banking room designed like ours, by extremely annoying and nerve wracking if not properly subdued and toned down.

Finally, after the usual routine of our architects, Meurs, Vosmeer, Boldt and Muller, and after several inspections of buildings so treated, we decided on a Macoustic installation. We have been exceedingly well pleased with the results obtained from that installation.

The metallic clang of such mechanical devices seems to be completely absorbed, or at least subdued, to an extent that makes it unnoticeable and visitors in our building have frequently commented on the quiet atmosphere that pervades our banking room.

We would have no hesitancy in recommending Macoustic installation to any commercial institution that desires a comparatively soundless business room.

Respectfully yours,
M. S. COHN, Vice-Pres.

CLEVELAND THEATERS

MACOUSTIC ENGINEERING COMPANY, INC.
Cleveland, Ohio

Gentlemen:

With the formal opening of the new Guild Theatre, seating about seven hundred people, the final unit in the new wing additions of the Cleveland Public Auditorium group, I wish to inform you of the general opinion of the acoustical properties of the new auditorium, not only in this interior, but in the new areas of the auditorium, seating 3100 people.

Music Hall, recently opened, seating 11,000 people, has been of the acoustical properties and planning for decorative effect in the above interior has been of the acoustical properties and planning for decorative effect in the above interior has been of the utmost importance in the design and planning for decorative effect in the above interior has been of the utmost importance in the design and planning for decorative effect in the above interior has been of the utmost importance in the design.

Music Hall, recently opened, seating 11,000 people, has been of the utmost importance in the design and planning for decorative effect in the above interior has been of the utmost importance in the design.

Yours very truly,
HERMAN KREGELUS, City Archt.

WELLESLEY COLLEGE

MACOUSTIC ENGINEERING COMPANY, INC.
Cleveland, Ohio.

Gentlemen:

In reply to your letter of December 1 asking for our opinion of the Macoustic installation in our Botany Building, I am pleased to quote as follows:

"I am very glad to report that the walls of the lecture rooms are very satisfactory. The voice seems to carry without any special effort and the echo is reduced to a minimum. The general appearance is very satisfactory."

Very truly yours,

ST. LOUIS CATHEDRAL

Kurt P. Schmitt, of CONRAD SCHMITT STUDIOS, Milwaukee and New York, says:

We take this opportunity to explain why we sometimes go out of our way to recommend Macoustic.

There are any number of acoustical materials on the market, and as far as we know they are more or less satisfactory. However, until your product was introduced there was nothing, which to our knowledge was similar to a high-grade and permanent decorative treatment. From a standpoint of appearance, texture and finish, is no different from ordinary plaster. Consequently our artists are able to work in their regular manner. Neither is experimenting necessary.

We have had so much confidence in Macoustic that we have used it in all the murals in the new St. Louis Cathedral, which paintings are considered the most famous murals in this country.

It is always a pleasure for us to recommend Macoustic.

CLEVELAND RADIO STATION

Mr. W. A. Howlett, Manager of THE RADIO AIR SERVICE CORPORATION (WHK), Cleveland, says:

The unusually favorable comments that we have received from our radio audience, musical critics and artists, at the concerts, validate our opinion of the acoustical properties of your product, Macoustic, with which the walls and ceilings of our studio are treated. We were determined that the sound should be equal to the best, and Macoustic fully satisfies our requirements.

We have also been particularly pleased with the attractive lights used, and the decorative effects obtained through the use of your colored material.

We heartily endorse Macoustic as ideal for broadcasting studio installation.

Page 14
# 100 Typical Macoustic Specifications

<table>
<thead>
<tr>
<th>NAME</th>
<th>LOCATION</th>
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<td>Brooklyn Law School</td>
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<td>Bertram Goodhue Associates</td>
<td>Imperial School of Law</td>
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LATHING

Where suspended ceilings are required, we recommend the following construction. Use twenty-four (24) gauge lath, weighing not less than 3.4 pounds per square yard, sewed to $\frac{3}{4}''$ channel cross furring spaced not over twelve inches (12") center to center. All lath should be tied every four inches to cross furring. Cross furring should be attached to runner bars spaced not over 3' 6" to 4' 0" center to center.

MIXING AND APPLICATION

MIXING MACOUSTIC: Macoustic as delivered in bags is ready for mixing with clean water to the proper consistency. Use a liberal amount of water.

Macoustic must not be re-tempered under any circumstances. For this reason we recommend mixing small batches and applying promptly.

Caution: Be sure that mixing boxes, boards, hoes and tools are scraped and scrubbed clean and free from lime or gypsum plaster or other foreign material.

APPLICATION: Macoustic is applied in the same manner as ordinary plaster, using the steel trowel or wood float for laying on.

MACOUSTIC ON METAL LATH: We recommend first the application of a light scratch coat of gypsum plaster in the usual manner. Then when the scratch coat has set, double with a light brown coat of gypsum. Use no lime in either base coat. This brown coat to be scratched in all directions with a wood or wire scratcher. (Thus far the plastering operation is exactly the same as if the surface was to be finished in either hard or sand finish.)

Caution: Do not apply Macoustic over lime plaster nor over Portland Cement.

Macoustic should preferably be applied within four to twelve hours after the application of the brown coat of gypsum plaster, when the brown coat is in a half-green condition. Should several days elapse between the application of the brown coat and the application of Macoustic, the gypsum coat must be thoroughly wet down before applying Macoustic, thus reducing the suction to the proper degree and allowing Macoustic to dry slowly and most effectively.

We require a uniform thickness of not less than $\frac{1}{2}''$ of Macoustic and recommend the following method of application: Lay on an initial layer of Macoustic approximately $\frac{1}{4}''$ thick over a moderate area and then immediately double up with a Macoustic finish coat $\frac{1}{4}''$ thick.
By this method the initial coat of Macoustic will take a preliminary set and the finish coat may be given the desired or specified surface texture finish.

Macoustic, being of a fatty nature, is laid on faster and more easily than ordinary plaster.

**Caution:** Remove all plaster screeds or putty coat from the surfaces to which Macoustic is to be applied. Scratch or rake surfaces to remove all traces of lime.

**MACOUSTIC ON BRICK, TILE OR GYPSUM BLOCK:** The treatment over these surfaces is exactly the same as on metal lath, except that the scratch coat is omitted. It is only necessary to brown out the walls with gypsum plaster and then apply 1/2" of Macoustic as above.

We recommend that where Macoustic is applied direct to the interior of exterior masonry walls, that such walls be damp-proofed.

**MACOUSTIC ON WOOD LATH:** Apply Macoustic 1/2" thick over gypsum scratch and brown coat.

**SURFACE TEXTURES OF MACOUSTIC**

We generally recommend a stippled finish and best results will be secured by using one man to lay on Macoustic and to **follow up promptly** with a second man to perform the stippling operation. Best results can be secured by the use of a stiff bristle brush, special stippling brush, whisk broom or sponge. The labor cost for this finish is no more than for a sand finish.

Macoustic may also be “pulled” with a trowel or manipulated by hand like ordinary plaster, if antique textures are desired.

Macoustic can also be marked off to represent stone.

Do not use a smooth trowel finish.

**WHERE MACOUSTIC IS TO BE APPLIED OVER EXTENSIVE wall or ceiling area, that particular entire panel or section should be run in and completed at only one operation. In other words, it is not advisable with Macoustic, any more than with any other surface finish, to break off in the middle of a panel at the end of a day’s work, allow the material to dry over night, and then finish the panel the next morning. This precaution should be taken in order to avoid any possibility of a lap mark showing after the material has thoroughly dried out.**

**Caution:** Oil paints must not be used on Macoustic.

We will gladly supply information relative to proper methods for decorating Macoustic.

**MACOUSTIC ENGINEERING CO., Inc.**

**CLEVELAND, O.**
SABINITE ACOUSTICAL PLASTER

Incombustible • Economical

PHYSICAL CHARACTERISTICS

TYPES

- Sabinite A—For general use on ceilings or above
  wash basins.

- Sabinite B—For troweling to a smooth hard surface,
  readily cleanable on wash basins or wall surfaces
  exposed to abrasion.

- Sabinite 38—Specially developed to resist moisture
  in bathrooms, shower rooms, laundry, etc., when
  applied over Oriental Exterior plaster base. (See below.)

COMPOSITION—Sabinite Acoustical Plaster is a
permanent, reasonably priced, sound-absorbing pla-
ster. Sabinite A is substituted, over the standard scratch
and brown coats, for hard, sound-repellent plaster fin-
ishes. Sabinite No. 38 is applied over Oriental Exterior
Stucco base coats where extreme humidity, as in Na-
tatorium, is present. Gypsum base coats may be used
where humidity is less severe but a consult manufacturer
first. Sabinite absorbs sound because of its great mul-
titude of tortuous, minute passages, which have their
start in tiny openings at its surface.

ABSORPTION—Coefficients below are by the Official
Laboratories of the Acoustical Materials Association:

<table>
<thead>
<tr>
<th>Sabinite Type</th>
<th>Thickness</th>
<th>165 Cyc</th>
<th>250 Cyc</th>
<th>313 Cyc</th>
<th>439 Cyc</th>
<th>704 Cyc</th>
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THICKNESS—Applied 1⁄4-in. thick in two successive
coats, or 3⁄8-in. thick in three coats—each 1⁄4-in. thick,
with the usual plasterer’s tools.

APPEARANCE—Sabinite presents an interesting sur-
fate texture similar to a pebbled, semi-smooth stucco.
Sabinite A may be left with a troweled finish.

COLORS—Both Sabinite A and No. 38 are furnished
in white and four standard colors or tints: ecru, ivory,
cream, buff. Special colors will be furnished on orders
exceeding 5 tons. On small orders, Sabinite may be
mixed to special colors on the job.

Incombustible—Composed of inorganic aggregates
bonded together with gypsum plaster, long known as a
fireproofing material, it is incombustible.

Durability—Sabinite Plaster is as rugged and durable
as the ordinary sand float finish.

It is unaffected by dampness and does not shrink
or swell with climatic changes.

Sanitary—Because it contains no vegetable or
animal matter, Sabinite is sanitary. Like any gypsum
plaster, it is vermin proof.

Distribution—Sabinite is made at the principal
mills of the United States Gypsum Company, con-
veniently located for lowest transportation costs and
quick delivery.

Covering Capacity—One ton of Sabinite A ap-
liled in two coats, each 1⁄4-in. thick, will cover a sur-
face of from 100 to 110 sq. yds. The average plasterer
can apply 100 sq. yds. of Sabinite A to full specifica-
tions in 11 hours.

To mix this material, including delivery to the
mechanic, requires but 7 hours of labor.

A ton of Sabinite No. 38 covers from 60 to 75 yards
and requires 14 hours of a plasterer’s time and 8
hours of mixing labor per 100 sq. yds.

Application and Supervision—It is applied by
the plastering contractor in lieu of the usual finish.
Its installation is always supervised by an experi-
enced representative of the United States Gypsum
Company.

Easy to Apply—Nothing but water is added to
make Sabinite ready for application. It spreads with
a trowel from the hawk, like ordinary plaster and
bonds easily and firmly to the base coat.

Economical—The low cost of the material, ease of
application and excellent covering capacity, coupled
with its relatively high sound absorption, makes
Sabinite a most economical material.
Specifications - SABINITE ACOUSTICAL PLASTER

NOTE. Notes are explanatory or advisory only and should not be included in the specifications.

(1) WORK INCLUDED

NOTE. List and locate all walls and ceilings to be covered with Sabinite Acoustical Plaster. If Sabinite A, B and Sabinite No. 38 are used, list and locate separately. If different colors of integrally tinted Sabinite are used, specify the colors for the various areas.

(2) GROUNDS

On walls, in addition to the usual grounds set for the scratch and brown coat plaster base, set additional 1/4-in. [1/8-in.] thick grounds to assure proper thickness of the Sabinite and form mellowing for wood trim, etc. All corner beads shall be set to conform to the increased plaster thickness.

(3) ACOUSTICAL TREATMENT MATERIAL

(3a) Acoustical Treatment material shall be [Sabinite A] [Sabinite B] [and] [No. 38] Sabinite Acoustical Plaster as manufactured by the United States Gypsum Company.

(3b) Sabinite shall be integrally tinted by the manufacturer at the mill.

NOTE - Integrally tinted Sabinite should be a shade lighter than the same color would be in paint because the texture of Sabinite casts a slight darkening shadow.

(4) SCRATCH and BROWN COAT BASE

(4a) SABINITE A and B - All surfaces to receive Sabinite A [and B] shall be given scratch and brown coats of gypsum plaster containing no more than two parts of sand by wt. to one part of plaster.

(4b) SABINITE No. 38 - Hydratile Sabinite shall be applied over [Oriental Exterior Stucco] [Gypsum] Base Coat.

NOTE - Oriental Interior Stucco Base Coat is a prepared material requiring no sand or other addition except water. It is applied in two coats to the place of the regular scratch and brown coats. Use where humidity is severe.

(4c) The scratch coat shall be thoroughly broomed before the second or brown coat is applied. The second or brown coat shall be deeply roated after straightening.

(5) APPLICATION of SABINITE

The application of Sabinite shall only be made under the supervision of the United States Gypsum Company.

The plastering contractor shall arrange with the nearest sales office of the United States Gypsum Company for the supply of Sabinite and shall not commence its application until so directed by the manufacturer's service representative.

Sabinite shall be applied in [two] [three] coats each 1/8-in. thick over a thoroughly dry base coat. The second [and third] coat[s] shall not be applied until the previous coat has set. The instructions of the service representative for floating and brushing each coat shall be observed throughout regardless of his presence.

PAINTING SABINITE

SPRAY PAINTING - Sabinite may be spray painted. Depending on the conditions and the effects desired the United States Gypsum Company will make definite recommendations as to the paint or spraying lacquer to be used, the type of spraying equipment best adapted to the conditions and application specifications.
Directions for Using Sabinite Acoustical Plaster

Bases to Which Applied
Wherever Sabinite Acoustical Plaster is used, it shall be applied over a base coat of gypsum plaster. When the background is wood lath, metal lath or plasterboard, this base coat shall consist of one part gypsum plaster to two parts sand, by weight. When the background is gypsum tile, clay tile, or brick, the base coat shall consist of one part gypsum plaster to three parts sand. When the background is concrete, the base coat shall be Bondcrete, manufactured by the United States Gypsum Company, and applied in accordance with their directions.

On metal lath, and on other backgrounds when necessary, a light browning coat of gypsum plaster should be applied over the scratch coat to secure a true, even surface, so that the thickness of the Sabinite Acoustical Plaster, when applied later, will be uniform throughout. An equal thickness is essential for uniform appearance and acoustical properties.

In all cases, the surface to which the Sabinite is to be applied shall be thoroughly broomed, scratched or raked.

Sabinite Acoustical Plaster shall be applied only to a base coat that is half green. Good results will not follow over a base coat that is too wet. If the base coat has dried out, it should be wet down sufficiently to bring it to a half-green condition.

Mixing
Sabinite Acoustical Plaster requires only the addition of clean water to make it ready for use. Under no circumstances shall sand or other solid material be added.

1. Either a machine mixer or the ordinary hand-mixing box may be used.
2. The mixer, mixing box, mortar board, and tools must be kept perfectly clean.
3. Use clean water, free from alkali and impurities.
4. Use one (1) quart of water to each 80-lb. bag of Sabinite. If more water is required, it can be added by the plasterer on the mortar board.
5. The necessity of mixing Sabinite very thoroughly cannot be emphasized too strongly. Mixing should be continued after the period when it reaches its plastic state. This additional mixing increases its bulk, plasticity and the porosity necessary for its acoustical properties.
6. Do not mix more than can be applied within one hour.
7. Do not re-temper.
8. Do not mix part of one batch with another.

Application
1. Apply Sabinite only over a half-green base coat which has been broomed or scratched to present a rough surface.
2. Sabinite shall be applied in two coats to a total thickness of at least 3/4" over and above the base coat.
3. First apply a 3/8" coat of Sabinite. Straighten with darby, and as soon as the water has gone out of the surface, broom thoroughly with a clean broom. In brooming, be sure to keep the mortar well shaken out of the broom.
4. Then apply a second coat of Sabinite while first coat is half-green, bringing second coat to a full 3/4" thickness of Sabinite. Darby to a true surface. Generally at least 12 hours is necessary between applying the first and second coats of Sabinite.
5. For finishing use only a cork float (a carpet float will not produce a sufficiently open surface).
6. Do not use water in floating (water will seal the surface, thereby destroying its porosity).
7. Float a small patch, look along the surface toward the light; if the surface appears shiny it is still too wet to float.
8. Watch the surface carefully; a little practice will indicate the correct time to float. The surface must be left open and porous.
9. When a very rough texture is desired, a whisk broom may be used instead of a cork float.
10. To avoid showing the mark of joinings it is important to finish the side or ceiling of a room, once it has been started.
11. Because the cementitious component of Sabinite Acoustical Plaster is gypsum, the same precautions against dry-outs and sweat-outs should be taken as in the case of ordinary gypsum plaster.

See that Sabinite Acoustical Plaster is stored only in a dry place.