mechanism of the ear, the so-called resonance theory and was able to justify theoretically the law of Ohm. In the course of his investigations, he invented the resonator, now so well known by his name, and employed in modern acoustics for many applications. It is an interesting view of this great genius to recall that in 1859 he met the King of Bavaria and writing to his wife about it Helmholz said: "The King hoped that I would make some acoustic discoveries that would benefit the architecture of public halls – but I could hold out small prospect of that." Helmholz developed the theory of summation and difference tones and in general laid the ground work for all subsequent research in the field of auditoria. One of the greatest physicists of the nineteenth century, he touched no field that he did not enrich with his experimental and theoretical genius.

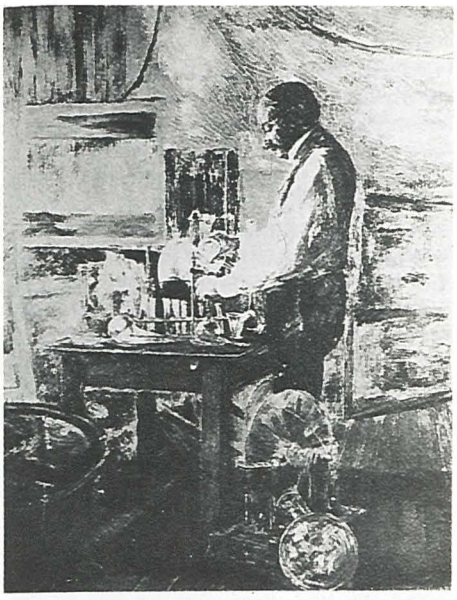
It was the work of Helmholz, published in 1862, which stimulated Lord Rayleigh's first work in acoustics which was a paper concerned with the pitch of resonators and finally led to the classic two volume work *The Theory of Sound*[4] published in 1877. It was a treatise of such importance that one hundred years after its publication it still retains a pre-eminent position in the literature of its field when most scientific treatises of much less age now possess, for the most part, historical interest only. From the eighteenth century onwards in addition to the work of the scientists, composers, musicians and architects became interested in the subject. The violinist Tartini and the composer Rameau were both interested in harmonics and the reason for the frequency interval between them. Since the reception of sound by the ear in enclosed spaces like rooms and auditoriums is a common experience, it was natural that some attention should be paid to them in the design of these spaces. The first discussion of improving hearing in rooms was limited to purely geometrical considerations such as the installation of sounding boards and reflectors. In 1858, a Boston physician, J. B. Upham, wrote several papers indicating a much clearer grasp of the more important matter involved, namely the reverberation or multiple reflection of the sound from all the surfaces of the room. He also showed how the reverberation time could be reduced by the installation of fabric curtains and upholstered furnishings. In 1856, Joseph Henry, the celebrated American physicist, who became the first secretary of the Smithsonian Institution, made a study of auditorium acoustics. This study showed a thorough understanding of all the factors involved, but his suggestions were all of a qualitative character. In spite of this work, the subject was generally neglected by architects. There were and still are gross misunderstandings of the nature of the problem and attempts were often made to correct acute acoustical defects by such inadequate if not absurd devices as stringing wires across the offending space.

In 1895 Wallace Clement Sabine, an assistant professor at Harvard University was instructed by President Eliot to propose changes for remedying the acoustical difficulties in the lecture room of the Fogg Art Museum, a building which had just been completed in Cambridge, Massachusetts. It is now known as Hunt Hall. His colleagues looked upon his new assignment as a grim joke and his senior professor warned him that he was "undertaking a problem that fairly bristles with difficulties, the extreme complexity of which seems to indicate that a complete solution is hopeless". About two years were spent in experimenting on this room and after a further three years of research, Sabine gave acoustics the classical reverberation equation.

Room Acoustics

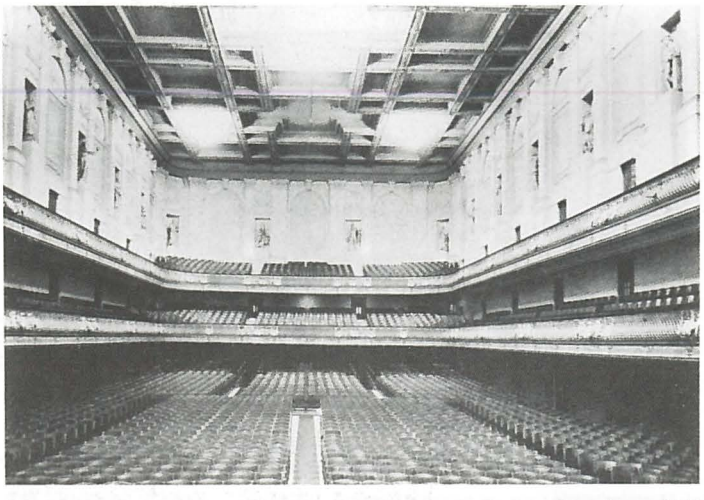
The history of the application of mathematics to the analysis of a sound field in an enclosed room is less than 100 years old. It is only 82 years since the building of the present Boston Symphony Hall, the first auditorium to have the benefit of acoustic guidance and analysis by Wallace Clement Sabine himself and still rated amongst the two or three greatest concert halls in the world.

Since Sabine's work at the turn of the century the learned papers and books have come thick and fast, but where room acoustics are concerned most acousticians have become either famous or notorious because of their work in the concert hall rather than the theatre. The first paper I



Lord Rayleigh in his laboratory at Terling; painted by Sir Philip Burne-Jones, 1888.

Wallace Clement Sabine.



Boston Symphony Hall.