enware, or other vessels, carefully graduated as to size, were placed under the seats, and were found greatly to strengthen the speaker's voice. Each vessel selected "from the speaker's voice a note which was in unison with itself, and by its resonance reinforced that note."

Cavities in the walls of buildings act in the same manner, as also do hollow spaces below the floor, or above the ceiling of a room.

Open spaces beneath the seats, below the floors, and behind the wooden walls of the theatre of the Royal Institution, add greatly to its acoustic properties; and in some of the opera-houses of Italy the orchestras are constructed of thin wood, with hollow spaces beneath.

Attention is also drawn to the difference between "this strengthening of the voice by resonance, and the "prevention of its decay by proper reflection and condensation,"—the two latter securing increased loudness, while the former "gives a musical character or richness to the voice of the speaker."

The answer to the enquiry as to how the large volume of air in a building can reinforce the comparatively rapid vibration of a speaker's voice, and the best form of buildings for acoustic qualities, we give in the author's own words:

"The air within a building behaves very much like the air in the interior of a gigantic organ-pipe. The entire mass of air in a large room, if it could be thrown into vibration as a whole, would yield a note of a pitch so low as to be quite inaudible. By subdivision, its parts can, however, vibrate more rapidly, and give rise to that resonance which is often called the *note* of a room. This note you may observe by making a noise in a room: a sharp ear can then often detect a faint musical sound lingering after the noise. So, in speaking, it is desirable to find the note of the room, and endeavour to pitch the voice to suit that note.

This brings us to the question, what determines these subdivisions?—for as they determine, to some extent, the acoustic properties of a room, whatever influences them must be important. An altogether satisfactory answer I cannot give. Two points, however, seem worthy of consideration—namely, the dimensions of a room, and the presence of rows of pillars in a regular series, recesses, &c., all of which, more or less, favour subdivision. In a flute, for example, the note can be raised by uncovering the holes, these holes determining the nodes of the vibrating column of air within the tube. Probably an action somewhat analogous may occur in a building. The *dimensions*, however, are also important. It appears that for good acoustic properties a building should be so constructed that its different dimensions shall be in some simple relationship to each other. An analogous effect is well known in music, for if two notes have the simplest possible relationship to each other's rate of vibration, as 1 to 2, or an octave, the combination of those two notes is more harmonious than any other combination. Next to this would be the rate of 2 to 3, or the fifth, and next the ratio of 3 to 4, or the interval of a fourth; the harmony decreasing with the simplicity of the combination. Further, in the case of three numbers a musical or harmonic proportion exists when the first is to the third as the difference of the first and second is to the difference of the second and third: thus, 2, 3, 6 are in harmonic proportions because 2 : 6 :: 1 : 3. And that an approach to an harmonic proportion between the three dimensions of a building is better than an unsymmetrical arrangement, gains some support by citing the following proportions of buildings famous for their good acoustic properties.

FREE TRADE HALL, MANCHESTER.

Height,	52 ft.,	or as 2;	unit, 26 ft.
Width,	78 ft.,	" 3.	
Length,	130 ft.,	" 5.	

ROYAL INSTITUTION THEATRE.

Height,	30 ft.,	or as 2;	unit, 15 ft.
Length,	45 ft.,	" 3.	
Width,	60 ft.,	" 4.	

WESTMINSTER CHAPEL.

Height,	50 ft.,	or as 2;	unit, 24 ft.
Width,	67 ft.,	" 3.	
Length,	120 ft.,	" 5.	

"In all you will perceive a very simple ratio of their proportions. The last quoted is a building recently erected, and has proved a great acoustic success. Besides its excellent proportions, this building has in its interior a smooth apse behind the speaker, which may assist, by reflecting the voice, and certainly with the curved ceiling prevents the waste of sound arising from oblique incidence. Then, the extensive wooden ceiling, and other wood surfaces, greatly aid by their reinforcement; and finally, the large hollow spaces above the roof and below the building, afford cavities where resonance can take place. I am inclined to attribute to this form of ceiling great value in the acoustic construction of large buildings.

"Such, then, is a rapid and confessedly imperfect outline of some of the more important points connected with the acoustics of buildings. Summing up what should be avoided, and what it is desirable to secure in the construction of buildings, as regards speaking, what we have learnt can be comprised under three heads.

"I.—*We have to avoid the waste of voice:* (*a*) by the production of rollers of sound from oblique incidence; (*b*) by echo and reverberation from improper reflection.

"II.—*We have to secure the prevention of the decay of voice:* (*a*) by condensation of the sound; (*b*) by proper reflection; and (*c*) by a proper arrangement of the seats.