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Vitruvius' Vases: Sound-amplification in ancient theatres

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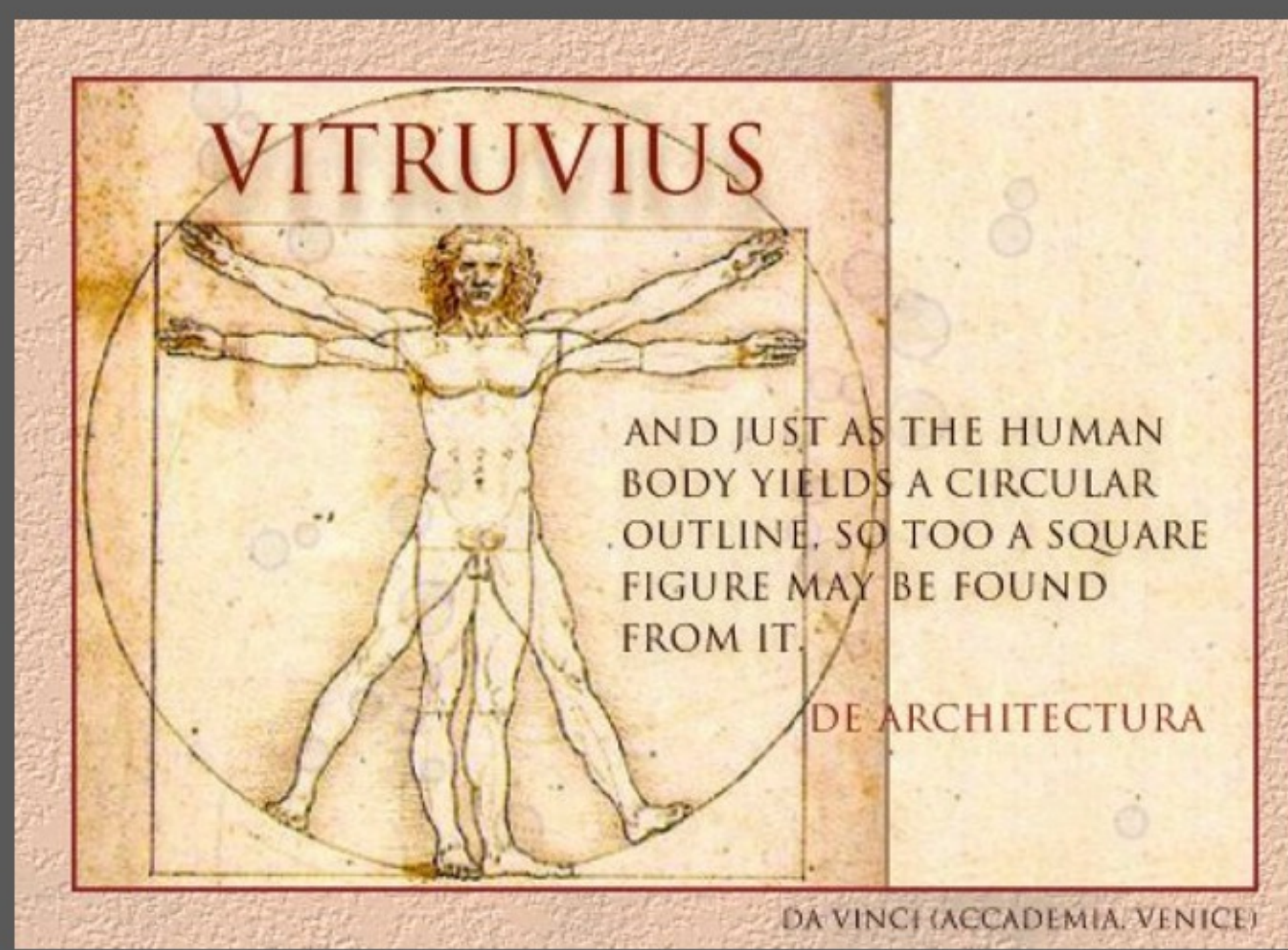
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Vitruvius' Vases

Sound-amplification in ancient theatres

Marcus Vitruvius Pollio was a Roman architect and civil engineer of the 1st century BCE. His famous work *de Architectura*, in ten books, ran the gamut from abstract mathematical principles of proportion (whence da Vinci's famous drawing of 'Vitruvian Man'), to practical matters such as construction materials, designs for town-planning, for temples, for monuments and theatres, for heating systems, waterworks, and military equipment such as siege-engines.

Two intriguing chapters in Book V offer a proposal for providing theatres with sound-amplification systems. In essence, these systems consist of large bronze vases, built to resonate certain notes, set in niches amid the audience seating. The plan is based upon the musical theory of Aristoxenus of Tarentum, a pupil of Aristotle, who had written his *Elements of Harmony* some two and a half centuries earlier.



Aristoxenus, whose proposals describe and organize the actual practice and experience of music, held that the main building block of the various musical scales was the simple concord of the fourth – a.k.a. the tetrachord – equivalent to the interval from C to F on a modern keyboard. In this interval there were four notes.

The bounding notes, at either end, were fixed notes: their relative position on the line of pitch never changed. But the other two notes, lying between the fixed notes, were called 'movable notes': movable in the sense that where you placed them determined the *genus* (≈ key) in which you were playing. Figure 2 shows the placement of the movable notes in the three genera, diatonic, chromatic, and enharmonic. Wherever in the pitch-line these movable notes were located, their names remained the same.

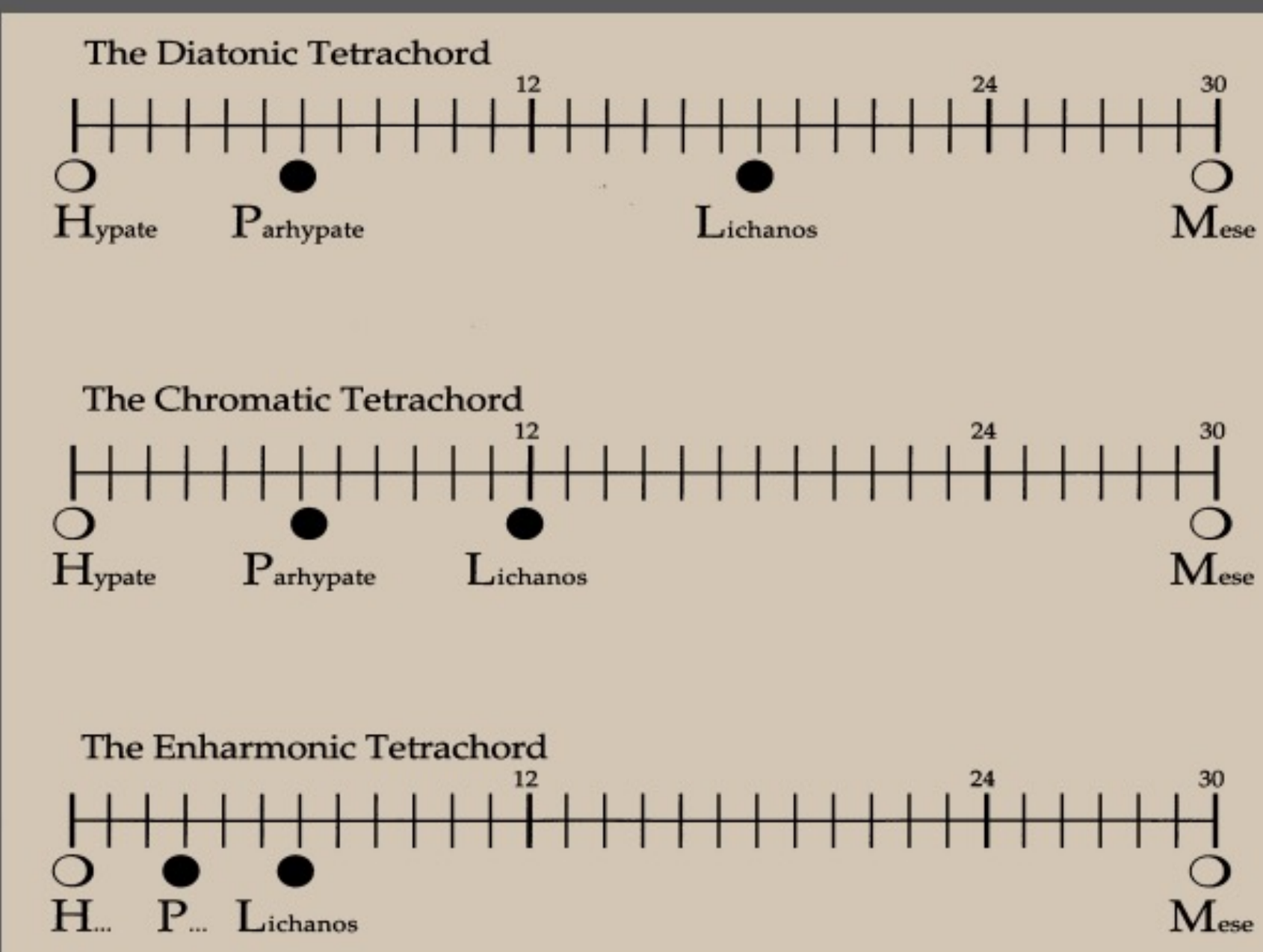


Figure 2: the three genera of the basic interval, the fourth. (The smallest divisions on the pitch line represent a twelfth of a tone.)

The scale of an octave was composed by joining one interval of the fourth (C to F on a modern keyboard) and one interval of the fifth (F to C'); the difference between the interval of the fifth and the interval of the fourth was defined as one *tone*. Hence the octave could be regarded as composed of a fourth and a fifth, or as composed of two fourths plus one tone.

The movable notes of the two fourths – two tetrachords – so joined, 'moved' in tandem: their collocation in both tetrachords would be the same, depending on which genus was being played.

The total performable range – the *Greater Perfect Scale* – was a span of two octaves, built up out of a series of fourths and tones. See Figure 3.

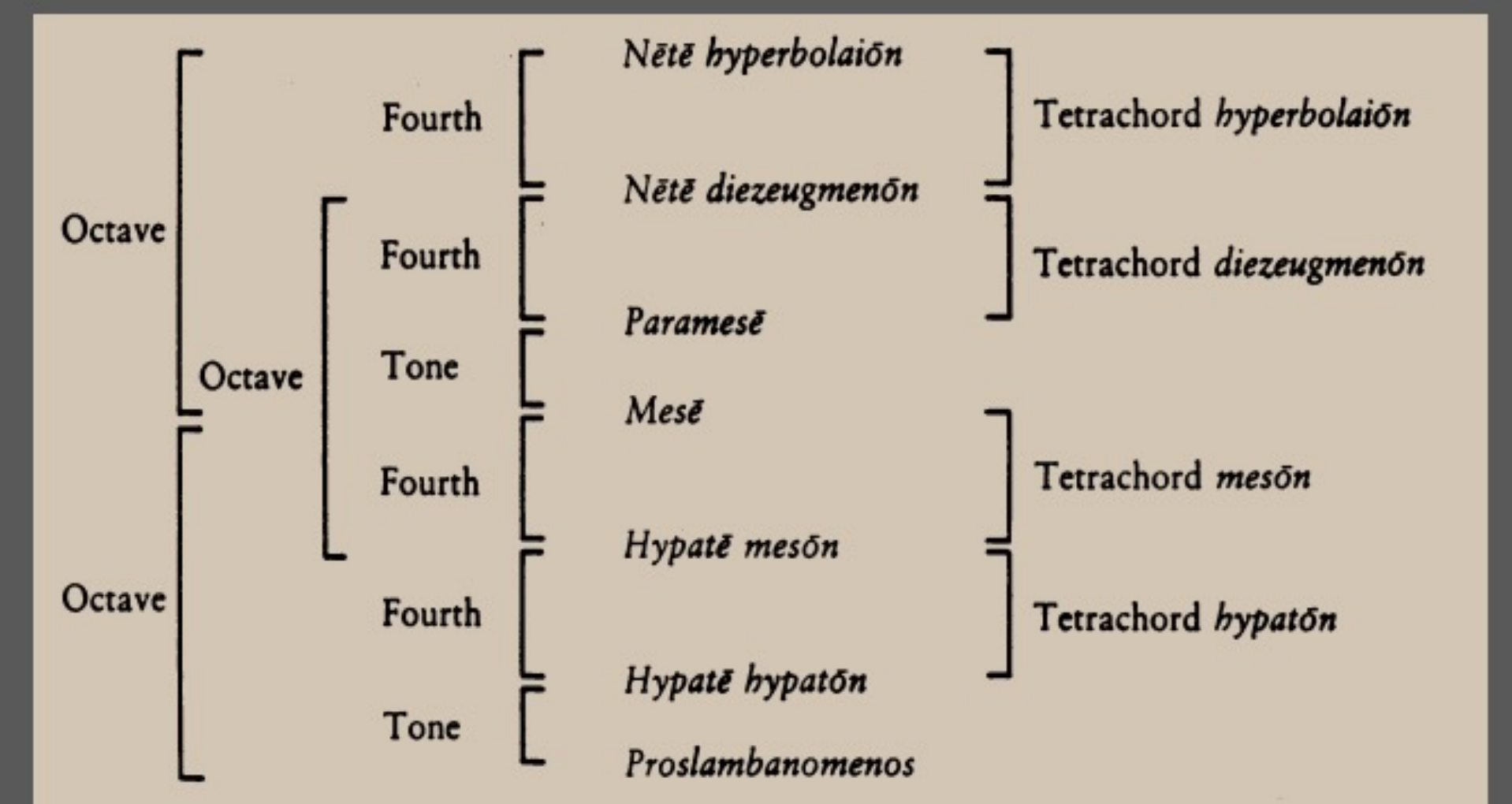


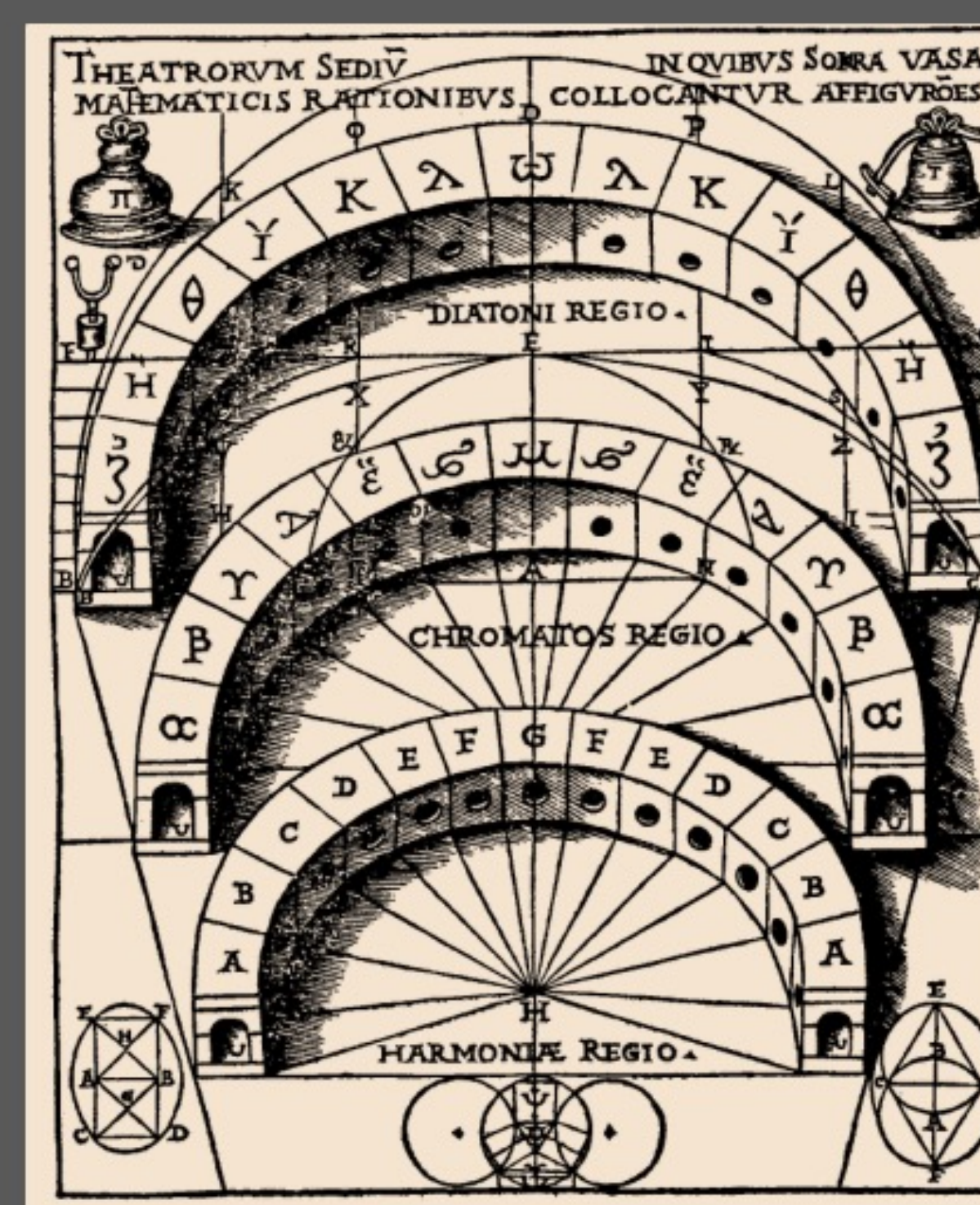
Figure 3: the Greater Perfect Scale (only the fixed notes are shown)

Vitruvius' scheme for amplification had two versions: one for small theatres and one for large. In small theatres it was fairly simple. Given seven fixed notes in the Greater Perfect Scale, the lowest note had a single resonating vase, placed in the middle of the semicircle of seating. Moving outward from there, on either side, were two vases for the second-lowest note; and moving further outward, two vases for the third-lowest note; etc. In this arrangement it is clear that *only the fixed notes* are amplified. The movable notes are treated as notes of passage.

In large theatres there is a rank of vases for each genus – the lowest for the enharmonic, chromatic in the middle, and diatonic at the top. (Figure 4.) The upper ranks are tuned to the *movable notes* in those genera, but the lowest rank is the same as that for small theatres.

Figure 4
The plan for large theatres, from Vitruvius, *De Architectura*, Italian edition by Cesare Cesariano, Como, 1521.

The notes in each of the three genera of the scale – enharmonic, chromatic, & diatonic – are amplified by vases in each of the three tiers of seats.



The archaeological evidence for these amplification systems is scant; we can nonetheless draw some conclusions about the plan.

- because in large theatres the lowest rank of vases covers both the fixed notes and also the movable notes of the *enharmonic genus*, each vase would have to be an *approximate* resonator, responding to notes over the span of a semitone.
- it is often said that there was no fixed pitch in antiquity; but if this apparatus were in use, musicians would have to tune their instruments – or their voices – to the properties of the theatre: the theatre itself would be the tuning fork!
- Depending where you sat in the audience, you would hear some notes more amplified than others. The middle seat of the bottom row would be the worst seat in the house: sitting there would be like sitting in front of the woofers at a rock concert!