

Ancient Metrology, Ibn al-Tahhan and the Maler and Frei Lutes. – Part 1.

“La metrologia non e scienza, e un incubo” (metrology is not a science it is a nightmare)

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Early systems of measurement were practical in their application measuring weight of essential commodities such as wheat, barley, water, oil etc by volume. Linear measurement used to create the standard cubic measures was based upon the width of a human finger(s) and so was convenient for use by the average person - approximate measurements that are often still employed in the market place in countries of the Middle East.

Although weights and measures have been subject to standardisation since very early times, these standards have varied widely over the centuries as well as from region to region. Historic metrology is a field of research that has attracted the attention of many scholars and great scientific minds (Sir Isaac Newton among many others) particularly in the study of the Pyramids of Egypt and Megalithic structures such as Stonehenge. Some researchers have come to the conclusion that these early structures had a significance beyond the ceremonial – that they were celestial observatories used by the ancients – experts in astronomy - to calculate the circumference of the earth (with astonishing accuracy) from which all ancient units of measurements have been derived (Note 1).

Although the work of many researchers involved in this field often makes fascinating reading, the approach of some has been highly speculative as well as bordering on mysticism so that historic metrology is now classed by the modern scientific community – in its infinite wisdom - as a pseudoscience.

Most scholars today dismiss as unproven the conclusion of Professor Livio Catullo Stecchini, in his unpublished work on ancient metrology, that all ancient measures are by definition related. Nevertheless it is of interest to examine what Stecchini has to say. Stecchini states that there were eight fundamental types of ancient ‘foot’ – a foot of 15 basic ‘fingers’, one of 16 ‘fingers’ (the basic foot), one of 17 basic ‘fingers’ and one of 18 basic ‘fingers’. The value of the ‘finger’ is constant at 1.875 cm. Stecchini also proposed a trimmed ‘finger’ unit equal to 1.85 cm.

Volume standard measures were equal sided cubes measuring 15, 16, 17 or 18 ‘fingers’ all related so that – for example - a cube with sides measuring 16 ‘fingers’ and filled with water corresponds in weight to a cube of 17 ‘fingers’ filled with wheat and one of 18 ‘fingers’ filled with barley. Stecchini then designates these as a ‘lesser foot’ (15 ‘fingers’), a ‘basic foot’ (16 ‘fingers’), a ‘wheat foot’ (17 ‘fingers’) and a ‘barley foot’ (18 ‘fingers’).

A cubit is 1.5 times a foot measure so that, for example, the common Egyptian cubit measured close to 45 cm and was equal to 24 ‘fingers’. The Egyptian Royal cubit measured close to 52.5 cm and was equal to 28 ‘fingers’. There were also other cubit measures including a longer Persian Royal cubit of 28 ‘fingers’ measuring 63.8 cm.

Examples of ancient cubit standard measuring rods survive so that the lengths of a ‘finger’ unit are known with some precision – the Egyptian standard being equivalent to 1.85 or 1.875 cm and the Persian 2.28 cm. The Egyptian cubit standard rods have the ‘finger’ units further subdivided as 2, 3, 4, 5, 6, 7 and so on up to 16.

Arab Navigation

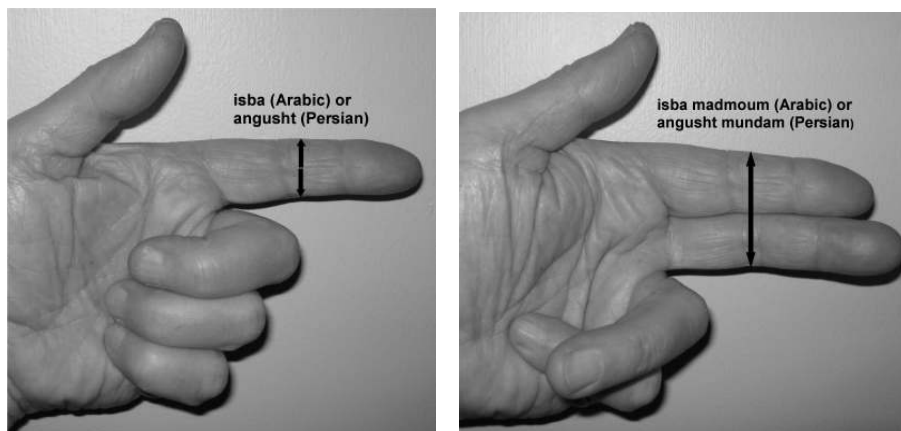
Arab seafarers navigated by latitude sailing – i.e. by sailing North or South until a required latitude was reached and then sailing East or West, while maintaining this latitude, until the required destination was reached. The latitude bearing was calculated (in the Northern hemisphere) by estimating perceived height of the Pole star above the horizon in unit ‘finger’ widths – achieved by viewing a forefinger (or more than one finger) held at arm’s length. The width of a finger viewed at arm’s length is equivalent to an angle of altitude of about 1 degree 36 minutes (the total angle estimated being the degree of latitude). The physical differences from person to person in finger width and arm length compensate each other to give a relatively consistent reading when using this method.

The invention of the ‘Kamal’ (‘guide’ in Arabic) standardized and improved the measurement of latitude. It was a rectangular sighting plate of wood, bone or metal (taking the place of the forefinger) attached to a string with knots tied along its length spaced at equivalent ‘finger’ unit height positions. The string was held in the mouth at a knot position and held taught while viewing the sighting plate thus providing a consistent measure of distance from the plate to the eye of the observer (Note 2)

The Arabs and Persians also navigated from early times with the aid of other instruments like the stellar compass and the sophisticated astrolabe calculator.

The ancient Arab measure of a finger width was ‘isba’ or ‘angusht’ in Persian.

‘Madmouma’ in Arabic (‘mundam’ in Persian) means “with no space in between” so an ‘isba madmouma’ is a linear measure equivalent to the width of two fingers placed together (Note 3).



Mediaeval Oud Geometry and the Farmer Translations.

There are three early manuscripts that make reference to the dimensions of ouds that date from the 9th to 14th C. Translations of the relevant parts of the texts have been provided by Dr H.G. Farmer (Note 4) - useful for those of us who do not have access to the original documents or a comprehension of the early Arabic and Persian languages.

Farmer states that both the Arabic ‘isba’ and Persian ‘angusht’, have a value of 2.25 cm. (so the ‘isba madmoum’ and ‘angusht mundam’ measure 4.5 cm.) and that the Arabic ‘shibr’ measures

27 cm. – but without providing support for his assumption (a ‘shibr’ is equal to 12 ‘isba’ but Farmer does not say so he just states what he believes is the metric equivalent).

A peculiarity of the ‘isba’ unit is that the plural form ‘asabi’ is only used after numbers 3 – 9, 103 – 109, 203 – 209, and so on (Note 5). Farmer does not always observe this distinction in his translations although it is not clear if he is just quoting directly from the manuscript source (in which case it is scribal error) or incorrectly translating the source document.

Farmer also notes a word ‘aqd’ used in the context of the length of the neck of an oud to which, without further explanation, he assigns a value of 2.25 cm. (i.e. equivalent to his assumed value for an ‘isba’ unit). In Arabic ‘aqd means ‘knot’, or ‘tied tightly’, or ‘knitted together’, or ‘joined’ or, more generally, ‘a binding agreement or contract’. However, one Arabic – English dictionary source also includes ‘inch’ in its definitions. It is now impossible to verify but perhaps ‘knot’ is an old Arabic nautical term associated with the ‘Kamel’ navigational instrument described above - a knot on the string being equivalent to a unit ‘isba’? If this is the case, however, why was the scribe not consistent in simply naming ‘aqd’ as an ‘isba’ which is the unit he used for the remainder of the measurements recorded? Has the scribe (or Farmer) misinterpreted the original text and so overestimated the length of the neck – as seems to have happened?

Alternatively, ‘aqd (more likely) may just be a reference to the point at which the neck of an oud is glued to the bowl i.e. the neck joint. This is the interpretation followed in this discussion.

Source 1. From the 9th C. philosopher and cosmologist Al-Kindi - the position of the plectrum guard (‘midrab al-awtar’) is fixed at a distance of 3 ‘asabi’ from the bridge. This position is given as a tenth of the total string length which Farmer, using his assumed value of 2.25 cm, states is equivalent to 67.5 cm. (so presumably is equivalent to 30 ‘isba’).

Source 2. From 14th C. Ibn al-Tahhan al Musiqi.

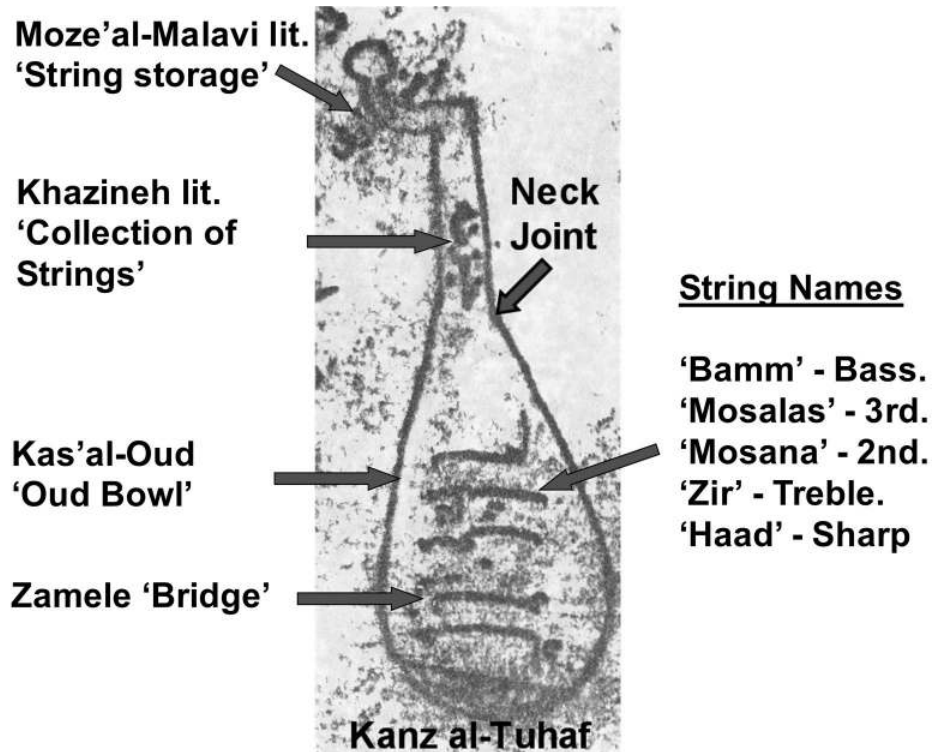
Here Farmer quotes the original dimensions of a four course oud as length = 40 ‘asabi madmuma’, width = 16 ‘asabi madmuma’, depth = 12 ‘asabi’. The bridge is placed at 2 ‘asabi’ from the bottom of the bowl (Farmer notes that this dimension seems ‘odd’). The neck length is given by Farmer as 1 shibr + 1 ‘aqd that he interprets as equivalent to 29.25 cm. Farmer also gives the length of the pegbox as 29.25 cm. again without further explanation.

Source 3. From the 14th C. Persian ‘Kanz al-Tuhaf’ (A Treasury of Music Rarities).

The dimensions of a five course oud are quoted as length = 36 ‘angusht mundam’, width = 15 ‘angusht’, depth = 7 1/2 ‘angusht’ and the bridge positioned at 6 ‘angusht’ from the bottom of the bowl. The length of the neck is given as a quarter of the overall length of the oud (i.e. 9 ‘angusht’).

The original measurements given in sources 3 and 4 are suspect – recently attributed by Curt Bouterse (Note 6) to a scribal mix up in the recorded dimensions confusing ‘isba’ and ‘isba madmuma’. Bouterse proposed corrected versions that are more reasonable proportionally but seems to have overlooked the possibility of another significant error in the interpretation of ‘aqd. Although Bouterse reasonably assumes the geometry of the lower part of the sound board to be a semicircle, he does not attempt to define a profile for the upper part of the sound board. The profile could, of course, be any one of an infinite variety of curves ranging from a straight line to concave or convex. However, the following sketch - said to have come from one of the manuscript copies of the Kanz al-Tuhaf (Note 7) – confirms that the profile of the oud (as might

reasonably be expected) is convex. Note the long, narrow almond shaped geometry and semi circular profile of the lower sound board. Note also the sharp transition between neck and bowl clearly representing a neck joint which in turn implies a 'built up' construction for the bowl. Both Ikwan al-Safa and Ibn al-Tahhan describe an oud with bowl made from thin strips of wood. These ouds were not 'carved from the solid' like the ouds from a much earlier period but were made with 'built up' bowls like the European lutes.



Persian 6th C. 'Oud' - Carved Construction

The Geometrical Construction – Methodology

- 1) Adopt the corrected dimensions proposed by Curt Bouterse.
Use only the original Arabic/Persian units in the construction not metric conversions.
- 2) Assume that the geometry of lower part of the sound board – below the point of maximum width (X axis) – is a semi circle.
- 3) Assume that the geometry of the upper part of the sound board – above the point of maximum width – is described by a circular arc of radius R with its center on the X axis exactly connecting the point of maximum width with the outer edge of the neck joint.
- 4) Assume that the neck joint width is 1 ‘isba madmoum’ (or 1 ‘angusht mundam’) - a reasonable dimension for either a four or five course oud.
- 5) For convenience and purposes of comparison, radius R is also given in terms of dimensionless basic units – the maximum width of a sound board always being 4 basic units (See Fig 4).
- 6) Assume that ‘aqd means ‘neck joint’ position not a unit of measure.

The Kanz al-Tuhaf Oud

The proposed geometry of this oud is shown in Fig 1. With a maximum width of 15 ‘angusht’ and a neck joint width of 1 ‘angusht mundam, a circular arc of radius $R = 32$ ‘angusht’ (or $R = 8.53$ basic units) defines the upper sound board profile. The string length is 30 ‘angusht’ identical to that of Al-Kindi’s oud.

Note that the neck length of 9 ‘angusht’ is sufficient to accommodate 6 frets. However, as the mediaeval fretted oud was fitted with frets only as far as the 5th fret position (Western equal temperament equivalent) this neck length is considered to be realistic.

For interest, note that if the neck is extended in length (in the direction of the neck block) so that the 7th fret position is at the neck joint (giving a neck length of 10 ‘angusht’ or one third string length) then $R = 8$ basic units (equivalent to twice the maximum sound board width).

The Ibn al-Tahhan Oud

(See Fig 2) With a maximum sound board width of 16 ‘isba’ and neck joint width of 1 ‘isba madmoum’, the upper sound board profile is again defined by $R = 32$ ‘isba’ identical to that of the Kanz al-Tuhaf oud. The neck length of 1 ‘shibr’ (12 ‘isba’) places the 7th fret position exactly at the neck joint. This is the classical neck proportion still found in ouds of today. Farmer’s value of 13 ‘isba’ for the neck length does not fit this geometry.

Overall length is then 40 ‘isba’ with a string length of 36 ‘isba’

In terms of basic dimensionless units, the upper sound board profile is described by an arc of radius $R = 8$ units.

Comments

It is interesting to observe that the oud widths - given as 15 and 16 'finger' units respectively – all agree with the ancient 'lesser foot', 'basic foot' and 'barley foot' proposed by Stecchini.

The actual size of these ouds expressed in metric units will, of course, vary dependant upon the value chosen for a unit 'isba' or 'angusht' – ranging from 1.850 cm (Stecchini's 'trimmed' unit) to Farmer's assumed value of 2.25 cm.

Taking Stecchini's natural 'finger' unit equivalent to 1.875 cm. the string length of the Kanz al-Tuhaf oud becomes 56.25 cm and its width is 28.13 cm. that of the Ibn al-Tahhan oud 67.5 cm string length and width 30 cm.

On the other hand if Farmer's 'finger' unit of value 2.25 cm is applied to the Kanz al-Tuhaf oud the string length becomes 67.5 cm and width 33.75. Likewise, the string length of Al-Kindi's oud also becomes 67.5 cm.

Note that the smallest size of a traditional Turkish (unfretted) oud with a string length of 54 cm ('girl's size') has a sound board width of 33.75 cm.

All of the above (or longer) string lengths would have been practical for a fretted oud but not for an unfretted oud where a maximum string length of about 62 cm is today generally considered the practical norm.

Ibn al-Tahhan gives instructions for tying gut frets to an oud but tells us that he did not need frets because he knew the place of every note on the fingerboard without them. So by the 14th C the practice of fretting an oud was being abandoned leading to the introduction of ouds with shorter string lengths. The Kanz al-Tuhaf oud with a string length of only 56.25 cm may, therefore, be an example of an unfretted oud of the 14th C.

Winds of Change?

By the 14th C an alternative design to the long string length, narrow of style oud had made its appearance – an instrument with relatively shorter string length and wider bowl of increased volume. This was achieved by reducing the radius of the circular arc R describing the upper sound board profile. An example of this style can be seen in the familiar engraving of an oud in a 14th C manuscript copy of the Kitab al-Adwar (Book of Modes) by Safi al Din (see Note 8 and Fig 3). The engraving is quite well proportioned. With a maximum body width of 4 basic units the upper sound board profile is described by a circular arc of $R = 4$ units and the lower sound board profile is a semi circle of radius = 2 units. The neck length is the classical proportion of 1/3 string length with the 7th fret position (Western 12 tone equal temperament) at the neck joint. The bridge is positioned between the widest point XX and the bottom of the sound board in the ratio 4:9. This geometric profile can be found in the surviving old Turkish ouds of traditional design and it is interesting to note that if the width of the sound board of the Kitab al-Adwar oud is made 33.75 cm wide then the string length becomes 54 cm – exactly as for a Turkish 'girl size' oud.

There are examples of lutes with upper sound board profiles of $R = 4$ units (Type 1) as well as more evolved designs of ouds and lutes with $R=5$ and $R=6$ unit (Type 2 and Type 3) profiles. There are no surviving examples of ouds with upper sound board profiles of $R=8$ (Type 5) but there are lutes with this profile to be found in the extant 16th lutes of Laux Maler and Hans Frei.

Notes

- 1) See for example “A History of Measures” by Livio C. Stecchini
<http://www.metrum.org/measures/index.htm>
“Secrets of the Great Pyramid” by Peter Tompkins and
“A Statistical Examination of the Megalithic Sites in Britain” by Professor A. Thom.
- 2) The ‘Kamal’ was most useful for measuring latitude in the range from 0 to 25 degrees making it suitable for navigation in the open waters of the Indian ocean.
The early Asiatic seamen also used the stellar compass and astrolabe for navigation.
- 3) For information, the metric measurement of my forefinger in these images is 2 cm for an ‘isba’ and just under 4 cm for an ‘isba madmoum’. Viewed at arm’s length, the angle subtended by my forefinger held at arm’s length works out to be 1 degree 38 minutes.
- 4) “The Structure of the Arabian and Persian Lute in the Middle Ages” from “Studies in Oriental Musical Instruments”, The Civic Press, Glasgow, 1939.
- 5) Source Mahmoud Korek. Mahmoud also confirms that ‘aqd means ‘knot’.
- 6) “Reconstructing the Medieval Arabic Lute: a Reconsideration of Farmer’s ‘Structure of the Arabic and Persian Lute’, The Galpin Society Journal, #32, May 1979.
- 7) Source yet to be verified.
- 8) Bodleian Library Oxford, M.S. Marsh 521 folio 157 verso. Manuscript copy dated 1333/4 written after the death of Safi al-Din (1216 to 1294). The engraving does not appear in all copies of the Kitab al-Adwar.

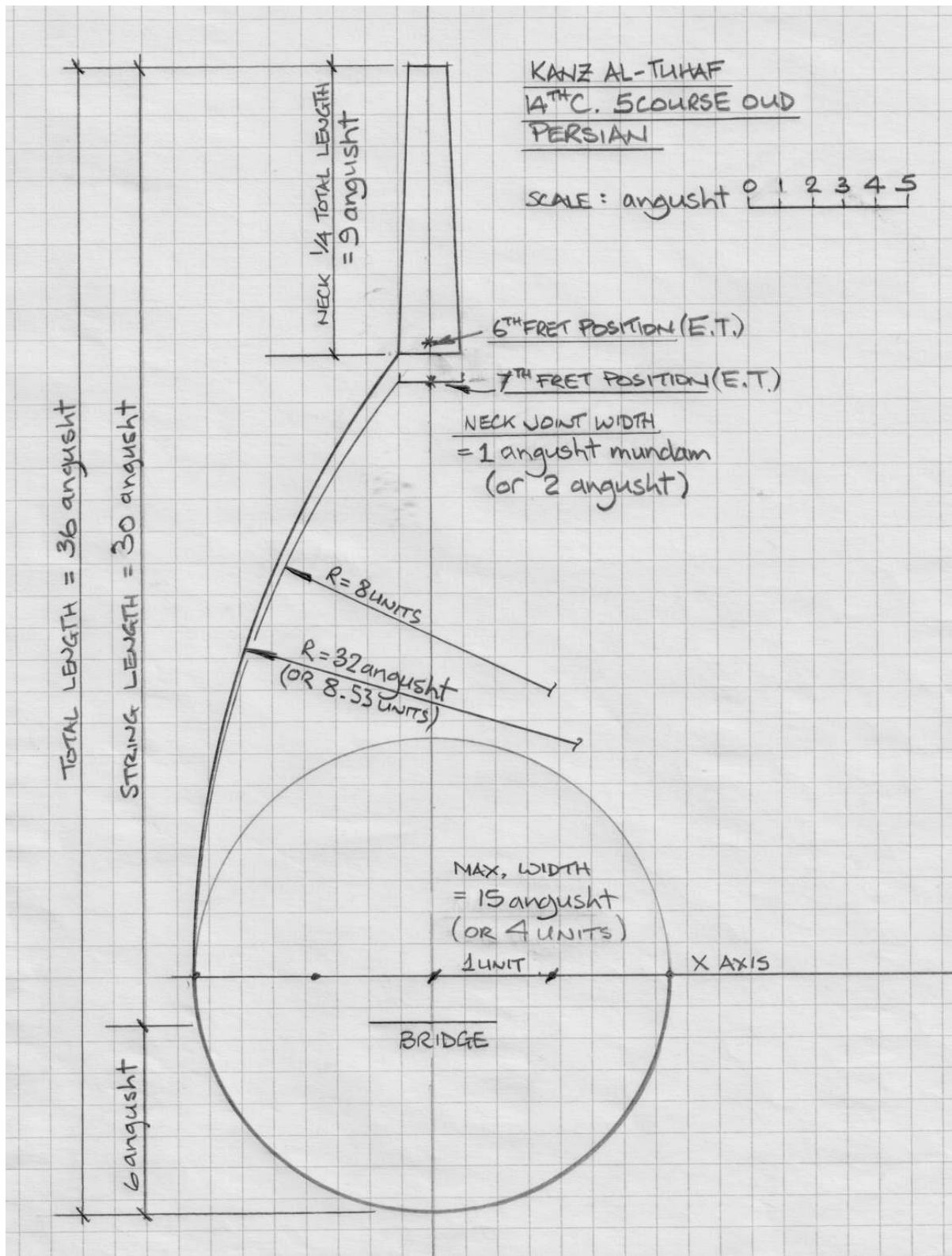


Fig 1

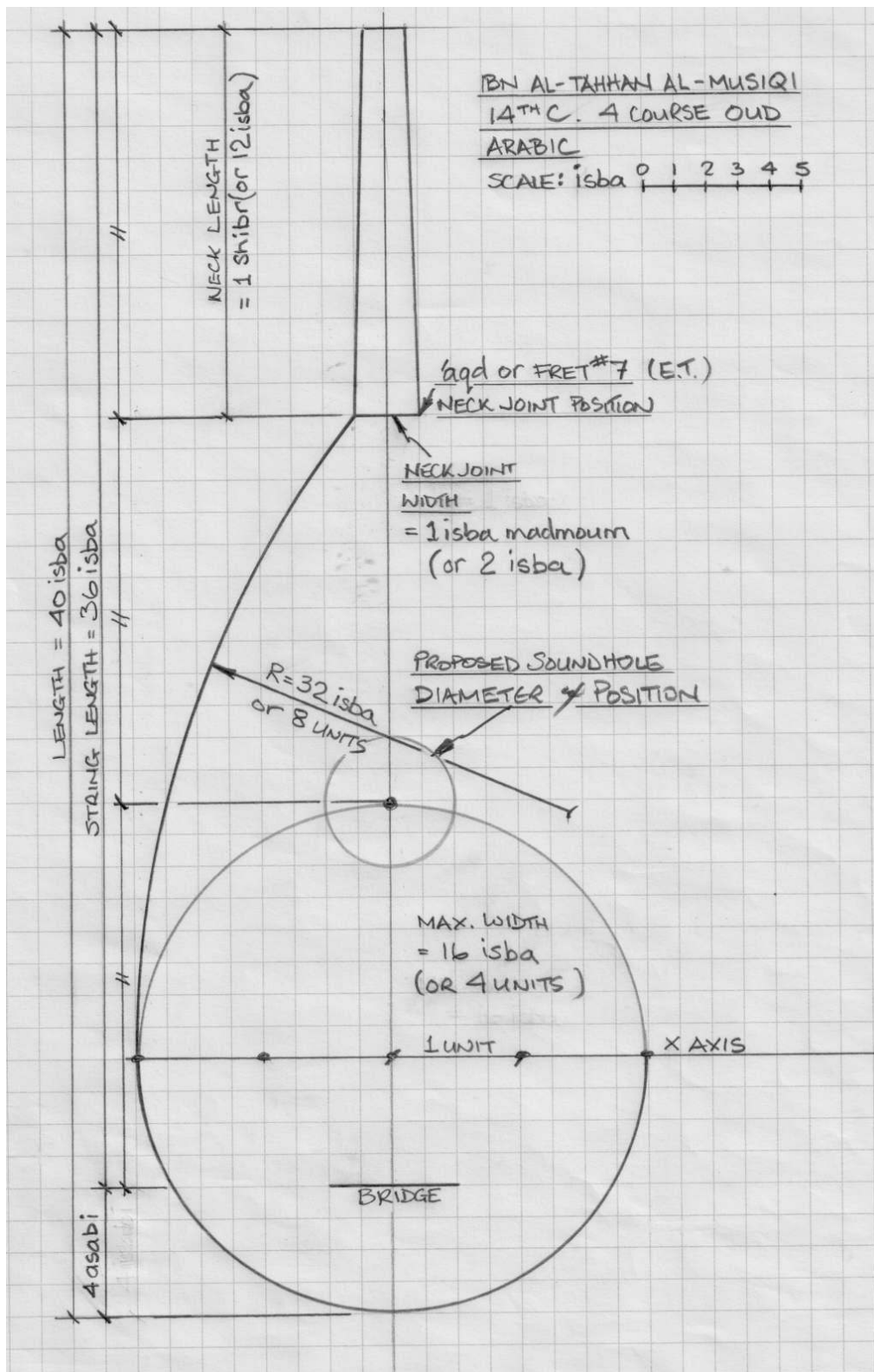


Fig 2

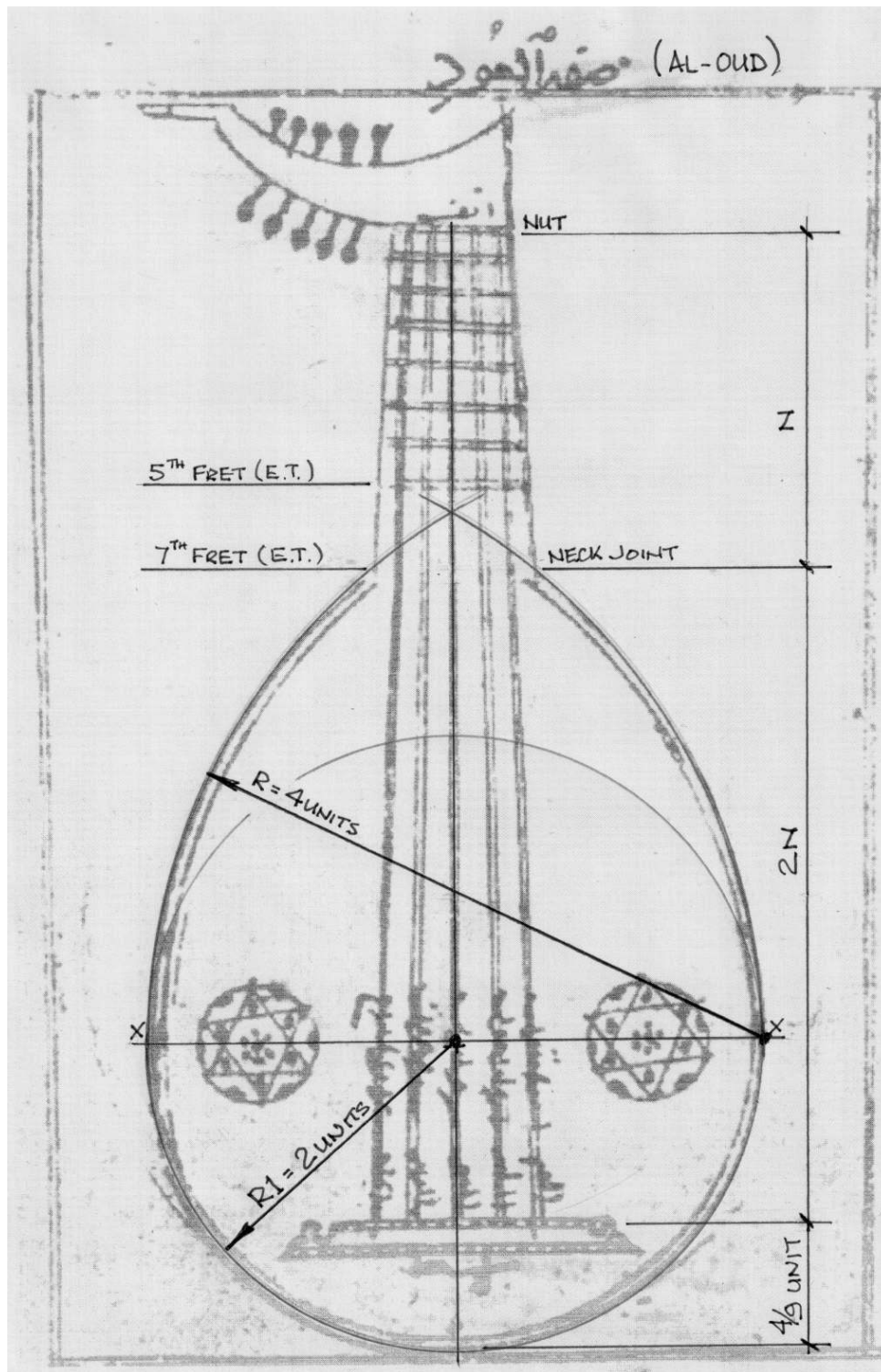


Fig 3

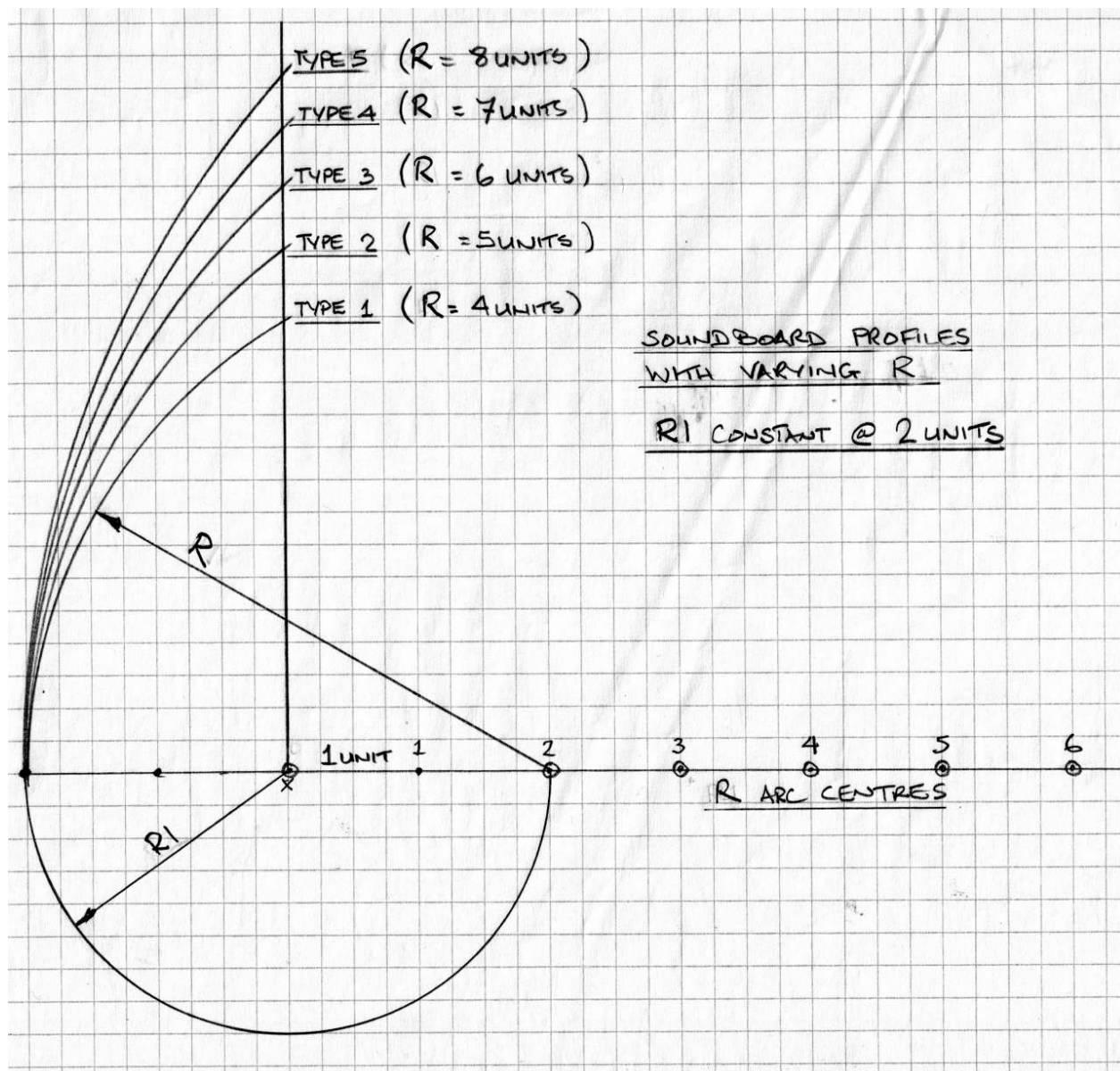


Fig 4