

# WOLF'S PLUMB BOB NEWS 2009

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OTTOMAN PLUMB BOBS

Editor: Wolfgang Ruecker

[www.plumbbob.de](http://www.plumbbob.de)

## ANATOLIAN / OTTOMAN PLUMB BOBS

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### A INTRODUCTION:

Dear Fellow Collectors,

In my last newsletter I wrote about the background of plumb bobs in articles found in old books. This month I return my focus of attention to plumb bobs themselves, and a most interesting subject, plumb bobs of an area of the world, succinctly referred to as "OTTOMAN" or "ANATOLIAN."

Over the last several years, plumb bobs of this type have become increasingly available on Ebay, worldwide marketplace. Yet, little has been written to create an overview of the unique types and uses of this distinct class of plumb bobs, which in Turkey are called, "Şakül."

These tools were made and used in a very large region, called the Ottoman Empire and especially in the Eastern part of Turkey, Anatolia. (Asia Minor)

This issue was written in collaboration with the plumb bob collectors Dogan Basak (DB), from Istanbul, Turkey, Elias Zacharopoulos (EZ) from Athens, Greece, and yours truly, Wolf Ruecker (WR), Germany. Revision of the English text made – as usual – by Nelson Denny (ND), USA. Thanks to all and also to the collectors who gave me the permission to show their pictures.

Dogan Basak presented this theme at the 2006 annual meeting of The International Association of Plumb Bob Collectors in Paris, France titled, "Anatolian Plumb Bobs". Watch for a copy of this presentation on my website [www.plumbbob.de](http://www.plumbbob.de)

It will be introduced onto my website after this newsletter appears.

## B 1 DIFFERENT TYPES of OTTOMAN PLUMB BOBS

In 2004 during a trip I made to Istanbul to meet with Dogan Basak, we collaborated on establishing a classification system based on shape using Dogan's extensive collection of Anatolian plumb bobs as the basis of this analysis. We identified 6 distinct shape categories that we numbered 1 through 6, and then further separated these 6 into those that were handmade individually as opposed to those of a later date that were mass produced. Of the handmade type, as one would expect, it was the very rare exception that any two were precisely the same weight, or shape or had identical decorative motifs. These, generally speaking, are the older OTTOMAN types and we refer to these examples as TYPES 1, 2, 3 & 5.

This newsletter will focus on TYPES 1, 2, 3 & 5.



Type 1



Type 2



Type 3



Type 4



Type 5



Type 6

## B 2 REGION

The plumb bobs featured in this article are from a distinct geographic area sometimes loosely referred to as the Ottoman Empire which existed during a distinct period of political history. Thus the name, “Ottoman Bobs,” has become a common name for these types. However, this terminology is not technically speaking correct in the sense, that these plumb bob examples were not necessarily made in the window of time encompassed neither by this political entity nor within the specific area that was encompassed by the Ottoman Empire.

Perhaps in geographical sense, not defined by a specific time period, Asia Minor, (including western Turkey and Anatolia), Greece and Bulgaria and enlarged by the Eastern Mediterranean areas (now known as Syria and Israel) are the important regions in which these plumb bobs were commonly found.

Of this large area it is rather difficult to reliably predict which types arose in which areas of the larger region referred to as Anatolia. However, Type 1 does seem to be associated with the western area of Turkey, Greece and Bulgaria and Type 3, with decorative variations, in present day Turkey, Syria and Israel. In the map below you can see a modern political map of the countries we refer to in this issue.

More about the Ottoman Empire see on Wikipedia: [http://en.wikipedia.org/wiki/Ottoman\\_Empire](http://en.wikipedia.org/wiki/Ottoman_Empire)



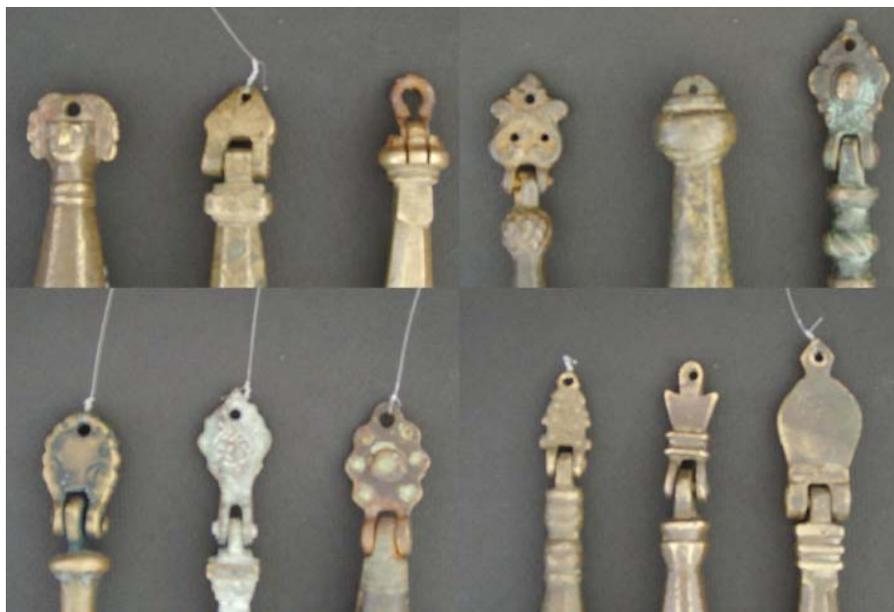
### B 3 TYPE 1

The Type 1 is characterized by the slender cigar-like shape of the plumb bob body. In addition to the “head,” “body,” and “tip” is an additional part, attached to the head by a pin, a “hinged medallion.” This appendage, truly unique in the world of known plumb bobs, the “medallion” has no immediately apparent functional advantage. Decorative without a doubt, the medallion leaves us to wonder its purpose. Considering that when put into use like most plumb bobs, it would work just as well if made in one piece; one wonders if the craftsman found in it a subtle purpose that has been lost over time. It is not uncommon to find examples of Type 1 bobs, missing the medallion; the hinge pins can easily become dislodged.

EZ: *“I am now pretty sure that the original pins were made of **brass**. Plumb bobs **with iron pins** were those repaired by builders using something found on the building site such as an iron nail.”*

The material is usually BRASS, with some exceptions made from iron.

On the pictures below you get an idea of the incredible variations found in the shapes of the “hinged medallions” and also of the bodies.



# OTTOMAN TYPE 1

Long time ago I started to make a grid with the different parts, but it is not yet ready.

<b>TYPE 1 BRASS 1</b>	1	2	3	4	5
Hinged medallion 1-1 (to fix the line)	coin 	house 	leaf 	ring 	tree 
HEAD 1-2 (upper part of the body)	round one ring 	round two rings 	wheel 1 	square 2 	turban 
BODY 1-3	eight sided 	four+ sided 	round1 	round2 	round and sided (combination) 
TIP 1-3 (lower part of the body)	(sharp tip) rounded				

Several years ago Dogan Basak made a big poster of a part of his "Type 1 collection" This picture illustrates the extreme variations of shape, size and symbolism. There are very few exactly the same, due to the hand production of these tools. (see poster below).



DOĞAN BAŞAK KOLEKSİYONU

EZ from Athens wrote:

*“The Ottoman plumb bob type 1 has two distinct characteristics, which together make its shape unique among the plumb bobs of the world: the slender, shuttle-like body and the “hinged medallion” on top of the head of the tool.*

*First, the small diameter of the body, I believe, is due to the fact it was used with the pointer finger as a “spacer”. Judging from the specimens we own and I have seen, I have concluded that the diameter of the ottoman plumb bob is roughly double the width of a man’s pointer finger. Using the finger as a spacer does not give a very accurate measurement, but it was adequate for stone-construction. When higher accuracy was demanded, a solid wood or metal spacer was added, but this led to the enlargement of the diameter of the plumb bob for practical reasons: the spacer had to be large enough to be handled by builders. I am aware that Dutch plumb bobs, being of small diameter, have their spacers, but there is no evidence that something like that existed for Ottoman Plumb Bobs Type 1. Type 2, 3, and 4 plumb bobs must have had spacers. Some are known with type 4.*

*In Greece, builders use two types of (modern) plumb bobs. The bricklayers’ plumb bob has a tip, which is used to point on the plan lines drawn on the floor (x, y coordinates) and raise them toward the ceiling (z coordinate). The plasterer’s plumb bob is cylindrical with flat bottom, because it is used only for checking perpendicular surfaces.*

*A further detail is that the line of the plasterer’s plumb bob is a short length of rope or cordon, which is less prone to tangle than a thin, long string.*

*Based on the above, I conclude that, at least, plumb bob type 4 was intended for checking vertical surfaces, while type 1 was for mixed use.”*

*Personally, I find this idea to be entirely probable. High precision is not necessarily the hallmark of working with irregular stone as a building material and I think that the breadth of a finger and the variation in different fingers is well within an acceptable tolerance for construction of certain types of walls.*

*Let’s say, if it wasn’t common to do it this way, I believe it is a great idea!”*

To better understand what Elias explained, I took a photo of his idea. (see right)

*Remark:*

Because of the weight of this plumb bob (500 Grams ~16 oz) the line strangled the blood flow to my finger.



Ottoman type 1  
with  
„finger-spacer“

## B 4 TYPE 2

The type 2 resembles the child's toy, a spinning top. To attach the plumb line, we find in older items a vertical hole centered in the top and an intersecting cross hole or a diagonal hole coming out the side. Modern examples look similar, but frequently employ threaded a brass cap to secure the line, a common feature of many plumb bobs.

This tool was created to be used with a spacer made of wood or brass. It is an enlargement, perhaps of the Type 1 to allow the spacer to be easier to handle and more manageable, as the tool is moved from one stone to the next. The central disc in the middle was an economical way to increase the tool diameter without adding unnecessarily to the weight.

In Greece the dealers called Type 2's "baby pacifiers", due to protruding nipple-like shape of the tip.



Picture above: Showcase Collection DB

## B 5 TYPE 3

The Type 3 was common to Turkey and with some modifications (more rings on the bodies) in countries east of the Mediterranean Sea. (Israel, Syria, etc.)

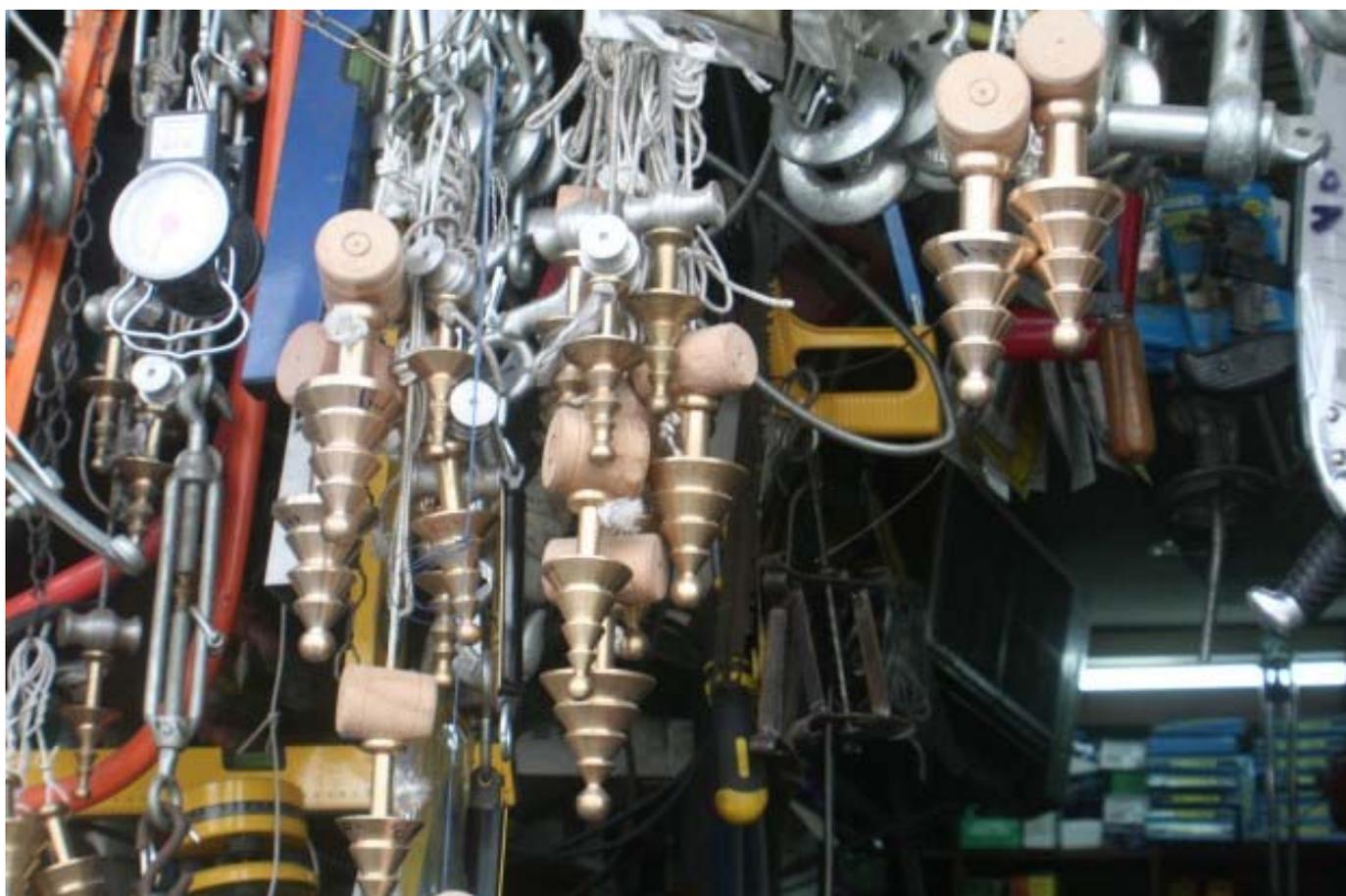


In Syria and Israel the shape differs somewhat, as some samples from the collection of Jean-Paul Michel, Paris, France, show:

Some look like an upside down Christmas trees:



Even today this shape is used in Syria, as a photo by Riccardo Chetoni, from Pisa, Italy, shows. This is a stall in a Syrian market in 2008. Note the big wooden spacers.



These pictures best describe the shapes of the Types 4. Type 6 see page 123 above.

**B 6 TYPE 4**



From the collection of DB

## B 7 TYPE 5 TERAZI (balance)

A very special shape, the **TERAZI** that does not look at first glance like a plumb bob at all, was actually used as a plumb level in the Greek and Turkish region of the Ottoman Empire.

Type 5 is a triangle made from brass. On the upper side it has two hooks. In the middle of the upper side is a hole to fix a line for a plumb bob. The filigree pattern inside the triangle differs from piece to piece and is decorative only. See pictures next pages. Unfortunately, some of the more delicate decorative elements are broken and lost.

The **sizes** of the “**Terazi**” (Tèrazi, Persian and Turkish word that meaning balance or level):

Thick: 4 – 6 mm (~ 3/16 in to 4/16 in)

Upper (horizontal) side: 80 to 160 mm (~3 to 6 in)

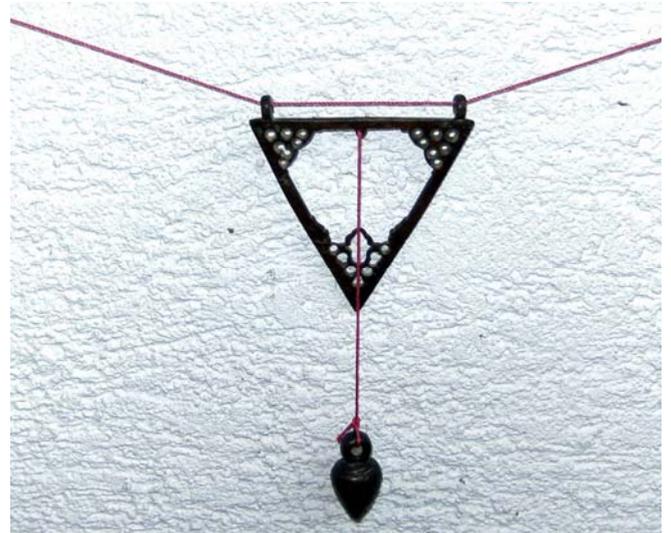
Other 2 sides: 110 to 200 mm (~4 ½ to 8 in)

The opening in the hooks is 2+ mm (~ 1/16 in)

This shows that the diameter of the braided silk line was nearly 1.5 mm (~ 1/16 in)



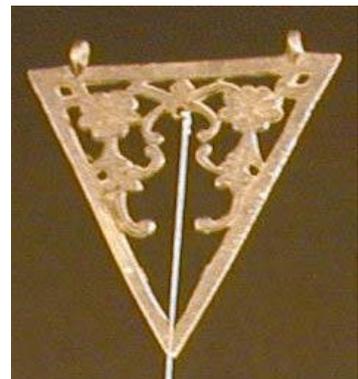
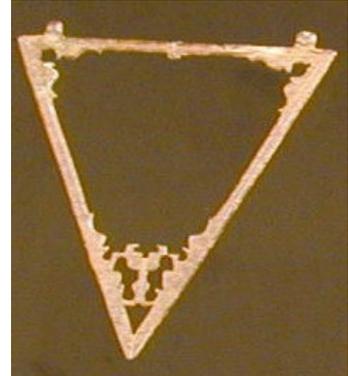
Picture left shows a very common shape. It is the one shape that we found in multiple examples, while all other patterns are unique. I assume that this item was produced in “factories” and sold in the last century or so.

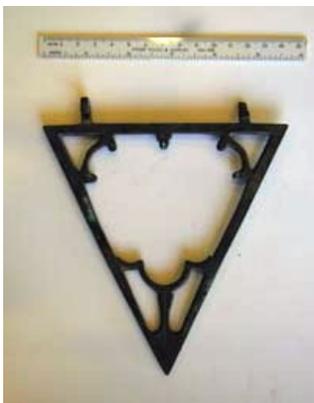
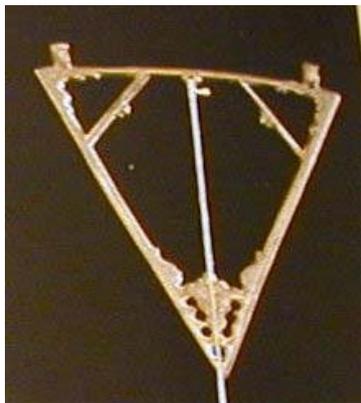


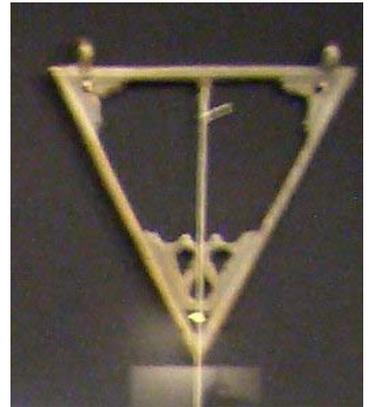
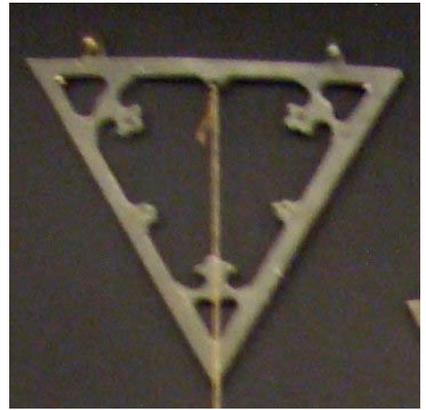
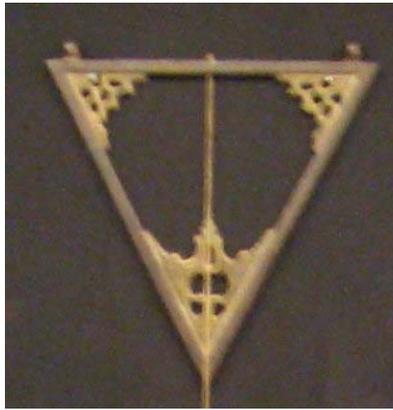
Picture right shows a plumb bob at the tip of the Terazi. Characteristically, the bob was small and different from Type 1, even though it is sometimes pictured together with a large Type 1. Some of these plumb bobs were not pointed, as their role was simply to provide weight to keep the plumb line under tension.

### Different decoration of the type 5

Here are the pictures of some of the type 5 triangle plumb bobs that we know (sent by friends or seen in museums or on ebay), (Sorry, all are not of the best quality),

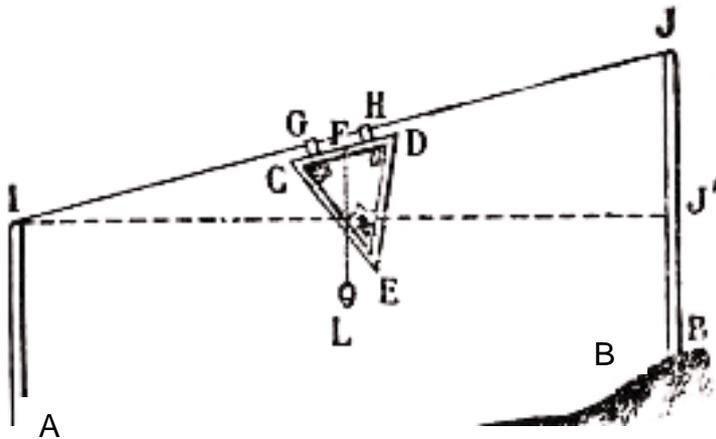






## B 8 USE OF TYPE 5 AND HISTORICAL BACKGROUND

French, Austrian and English publications that illustrate the “TRIANGLE PLUMB BOB”:<sup>1</sup>



Dear French plumb bob collector, Original text see last page D: supplement

“The tèrazi [ 1 ] or level with plumb bob of Beha-Eddin (16th century). –

In his writing “Geometric Calculations”, the Syrian author Beha-Eddin (1547-1622) described a leveling tool used with a plumb line or “tèrazi.” A similar device was also known of in Poland and recorded by Strumieński in 1573. This type of instrument was the tool of preference for the surveyors, “fountainiers,” of Constantinople (Istanbul), Turkey, at the beginning of the 19th century.

This is how they would go about their work: Consider that you want to know the difference in level between the two points A and B in the figure shown above. First you would set two poles at points A and B. Then you would mark on those posts, points I and J so that the measurement from A to I and B to J are equal. The posts would also be checked for verticality by using a plumb bob and line. Then, between I and J you would stretch a line and in the middle of that line you would hang from hooks G and H an isosceles triangle frame, CDE, made of metal. (This is a type of plumb bob, identified by Basak and Ruecker as “Ottoman Triangle Bob Type 5”). From the middle of the base of the isosceles triangle at point F you would hang a plumb bob and line.

If the string aligns with the point E of CDE, the line IJ is horizontal. Thus, because the posts located at A and B are equal in height, the points A and B are at the same elevation. However, if the plumb line cuts one of the sides of the triangular frame, EC for example, you would lower the line at J to a point J' so that the plumb line swings into alignment with point E. Simply then, the measured distance between J and J' is equal to the difference in elevation between points A and B.

When the distance between the two points A and B was unusually large, intermediate posts would be erected between points A and B, so that a series of intermediate elevation measurements would be recorded and added together to equal the total difference in elevation between points A and B.

Note:

[1] Tèrazi, Persian and Turkish word that means balance “

This year I found another source with written information and pictures of the Terazi in:

<sup>1</sup> : <http://vulgum.org/spip.php?article751> (web site no longer available)

**CONSTANTINOPLE AND BOSPHORE THRACE DURING THE YEARS 1812  
AND FOR THE YEAR 1826. PAR M. LE COMTE ANDREOSSY. PARIS 1828.**

**CHAPTER VI. ABOUT TÈRAZI AND LEVELS:**

“free” translated from French: (original text see Supplement, last pages)

“All the information in this essay relates to a engineering project that would bring fresh water to the city of Constantinople (now Istanbul) and its suburbs from a source six miles distant from the city gates. The terrain between the reservoir and the city is highly uneven thus requiring a complete study of the path for the gravity piping system. The countryside through which a natural watercourse runs is densely wooded and virtually inaccessible except on foot. Thus, the survey of the proposed water course required a great deal of skill and ingenuity to achieve the most accurate results.

The surveyors, without a doubt, managed to execute the mapping of the terrain by employing an instrument called Tèrazi. The antique simplicity of this tool makes the successful completion of this task even more miraculous. The Tèrazi is still in use in Constantinople today (1825), although the water level is already known. We will describe the Tèrazi, and how it was used in this particular application where the “water level” would have been impractical if not impossible to use in many segments of the path of the proposed watercourse.

The Terazi is simply an inverted mason’s level, frequently referred to as an “A Frame” a device of great antiquity. In the Tèrazi, the “A” of the “A Frame” is inverted with the tip of the equilateral triangle pointed down with the base of the triangle at the top. Two hooks spaced symmetrically along the base, allow it to be suspended from a string line. The precise attachment of the line at either end is key to the accurate deployment of the Tèrazi. The middle of the Terazi must be set precisely in the center between the ends of the line. In the center of the top of the Tèrazi which is also the center of the dimension between the two hooks, a plumb line and plumb bob is suspended. While one end of the string line remains fixed the other end is raised or lowered until the line of the plumb bob aligns with apex of the Tèrazi triangle. When this alignment has been achieved it can be said that an imaginary line between the two ends of the string line is “level.” The final step in measuring the average slope of the terrain between the two posts is to measure the distance from the ground to the end of the string line on each post. The difference in these two dimensions is the numerical slope of the terrain over the measured horizontal distance between the two poles.

Instead of writing these dimensions down, early Greek surveyors counted the difference in the heights of the posts on a string. The successive differences obtained, they “transferred” them, in sequence onto a length of string which they kept rolled around the last four fingers of the left hand. By grasping the string with the thumb and forefinger at the measured length on one pole it would then be employed on the next pole as the starting point for the next measurement to be taken on the next pole. When the distance from all the poles was transferred to the string they would then unroll the string and measure the overall length from the first point to the last. That overall length would then equal the total distance in elevation from point A and point B.

The string lines spanning between the posts were made of braided silk. Their lengths were typically about fifteen to twenty fathoms (1 fathom = ~ 1.8 meters = ~6 feet). The poles were marked, like a ruler, in units of dimension, such as meters, centimeters and millimeters or feet, inches and fractions of inches.

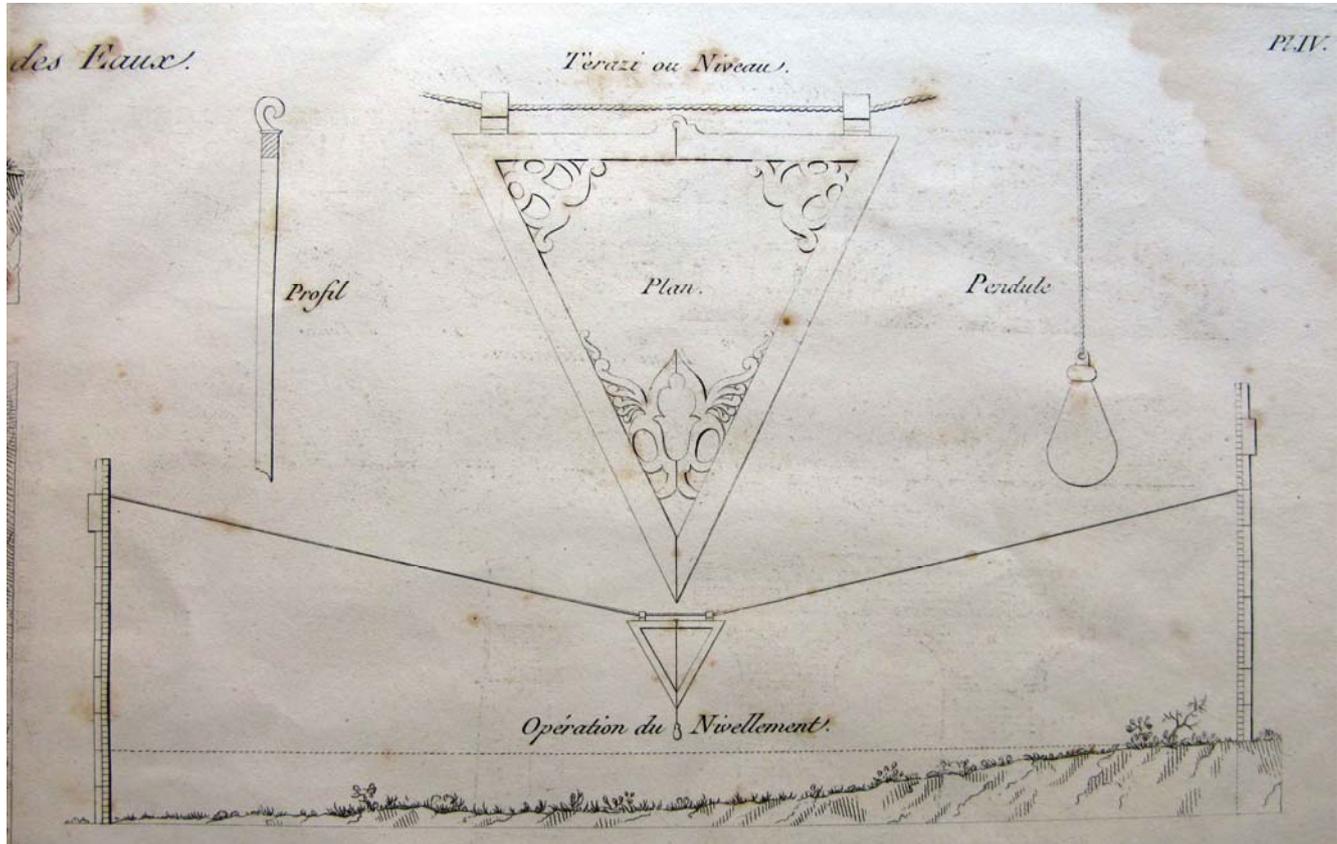
It is clear that it would be difficult to find a simpler or more portable slope measuring *device than the Terazi*. *If due to the limited length of the string line and the distance between posts*, the surveyors were required to plant many posts, the advantage remained in the accuracy of their measurements over these moderately short distances.

Two comparative surveys were conducted along the same path and the same terrain near Constantinople, on 4 June 1814. One employed the Terazi, the other measured with a water level that Andreossy had built. Both methods yielded more or less the same result.

Romans surveyors in the time of Vitruvius the architect of Emperor Augustus, employed methods and instruments for leveling that were relatively speaking, imperfect. This was an assessment made by Vitruvius himself. We do not know exactly, if a century later, when Frontin was superintendant of water and aqueducts of Rome, if the art of leveling had improved. It seems to be agreed says the historian of the Academy of Sciences, “surveyors could not dispense with the use of the standard imperfect methods used for laying large water pipes. But as these level tools were very imperfect, they were obliged to lay their pipes with much more slope than was necessary. Currently, with levels created by MM. Picard, Huyen, Roemer, La Hire,(French surveyors) we have seen miracles of improvement in these instruments.”

The instruments for leveling did not inspire much confidence until the large water companies, such as the “Canal Of Languedoc” and “Conduct Water Versailles”, France led in the development of these instruments. Between these two eras, that began probably in the Greek and Roman Empires, we cannot know with certainty a time for the invention of the Tèrazi. Furthermore, there is no evidence either in Turkish art or written sources that the Tèrazi’s origins were there.

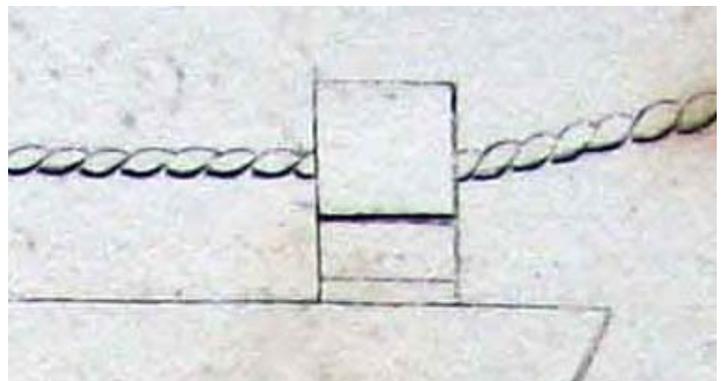
Drawing below from the book ANDREOSSY 1828: Terazi with plumb bob suspending in the middle of the braided silk line between 2 surveying rods. (description see above)



The line is NOT STRETCHED. The Terazi has to hang exactly in the MIDDLE of the line.

Details of the **hook** and the **braided silk line** (1.5 to 2mm ~1/16 inch diameter)

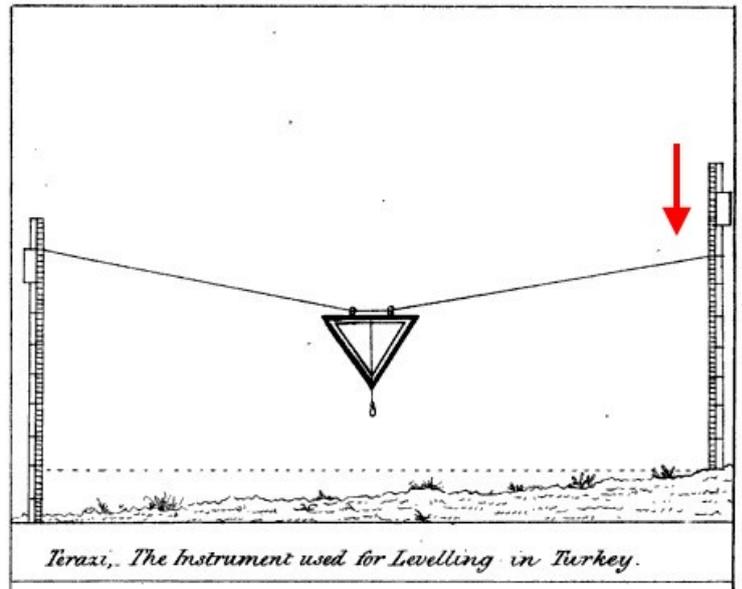
The hooks are bent in the same direction.



From “HYDRAULIA; THE WATERWORKS OF LONDON 1835” page 233 I got 2 drawings and a description:

“... The principle sources of the water are about fifteen miles distant from Constantinople; and in order to ascertain the proper declivity of the ground for the line of water course, an instrument is employed resembling an inverted mason’s plummet, and having the name – **TERAZI**. This contrivance being suspended from the middle of a cord, stretched between two rods, accurately divided into inches and parts, and set upright, by its successive removal from station to station, the surveyor ascertains the precise slope for the gradual flow of water.....”

The picture right shows the use of a TERAZI



## B 9 SU TERAZISI (water towers)

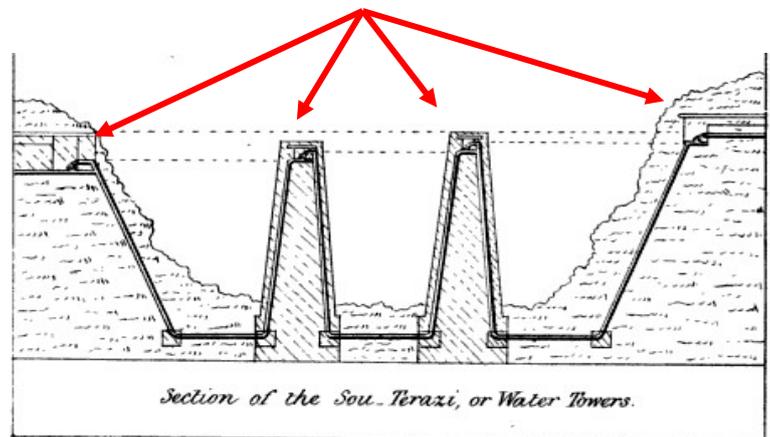
The next information are not directly related to the plumb bob, but were very interesting to me.....

Picture below the SOUS TERAZI. (Water towers)

[(water towers placed in valleys which acted on the principal of hydraulic levels and served as inverted siphons)]

In Turkish they were called SU TERAZISI, in French SOUS TERAZI and in German Su Terasi...

“... Singularity and ingenuity characterize the method of conveying water from the reservoirs to Constantinople, and the estimated expense amounts to about one-fifth only of the sum required for erecting large aqueducts, though several of these noble structures have been formed to convey the water across the valleys. Through the greater part of its course the conduit consists of earthen pipes, but square buildings, called **SOUTERAZI**, are erected at different points upon the declivities, between the reservoirs and the city, and the level of the top of every successive pillar in the same range varies, so that their descending direction is analogous to an inclined plane commencing at the mountains. There are several ranges of these quadrangular obelisks, which present a peculiar and rather an unpleasant prospect to persons, who may not be aware of their purpose, and therefore cannot appreciate their utility. ....”



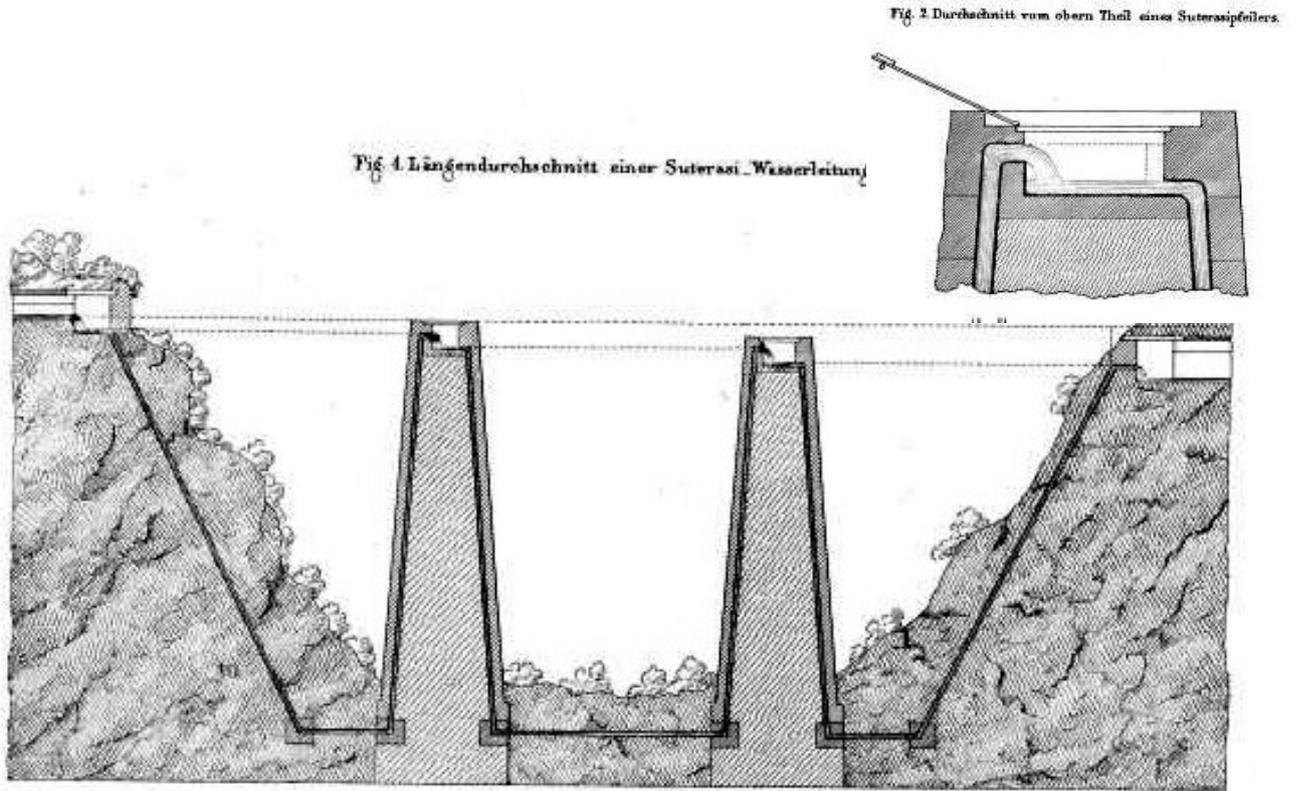
“... Singularity and ingenuity characterize the method of conveying water from the reservoirs to Constantinople, and the estimated expense amounts to about one-fifth only of the sum required for erecting large aqueducts, though several of these noble structures have been formed to convey the water across the valleys. Through the greater part of its course the conduit consists of earthen pipes, but square buildings, called **SOUTERAZI**, are erected at different points upon the declivities, between the reservoirs and the city, and the level of the top of every successive pillar in the same range varies, so that their descending direction is analogous to an inclined plane commencing at the mountains. There are several ranges of these quadrangular obelisks, which present a peculiar and rather an unpleasant prospect to persons, who may not be aware of their purpose, and therefore cannot appreciate their utility. ....”

The **Encyclopedia Britannica 1911** explains how it works:

"The souterasi," says Andreossy, "are masses of masonry, having generally the form of a truncated pyramid or an Egyptian obelisk. To form a conduit with souterasi, we choose sources of water, the level of which is several feet higher than the reservoir by which it is to be distributed over the city. We bring the water from its sources in subterranean canals, slightly declining until we come to the borders of a valley or broken ground. We there raise on each side a souterasi, to which we adapt vertically leaden pipes of determinate diameters, placed parallel to the two opposite sides of the building. These pipes are disjoined at the upper part of the obelisk, which forms a sort of basin, with which the pipes are connected. The one permits the

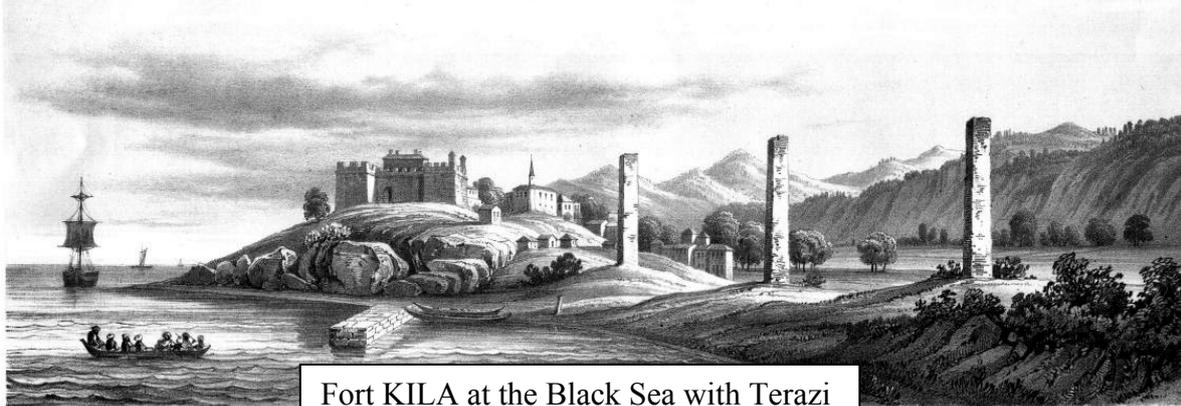
water to rise to the level from whence it had descended; by the other, the water descends from this level to the foot of the souterasi, where it enters another canal underground, which conducts it to a second and to a third souterasi, where it rises and again descends, as at the last station. Here a reservoir receives it and distributes it in different directions by orifices of which the discharge is known."

The drawings below are from "Allgemeine Bauzeitung Österreich 1835" an Austrian publication.



DIE WASSERLEITUNGEN VON CONSTANTINOPEL.

Bl. 529.



Allgemeine Bauzeitung 1835.

Fort Kila am schwarzen Meere mit seinem Souterasi.

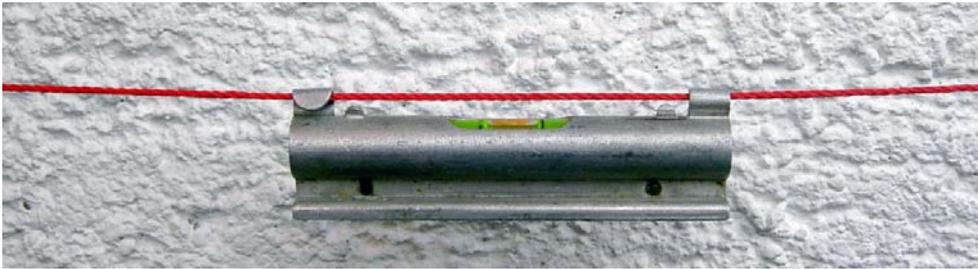
## B 10 WHAT WAS USED LATER

Later (1900s) so called "LINE LEVELS" from Aluminum with vials /water bubbles were used.

See patent US 1369652 HALL 1921 etc.

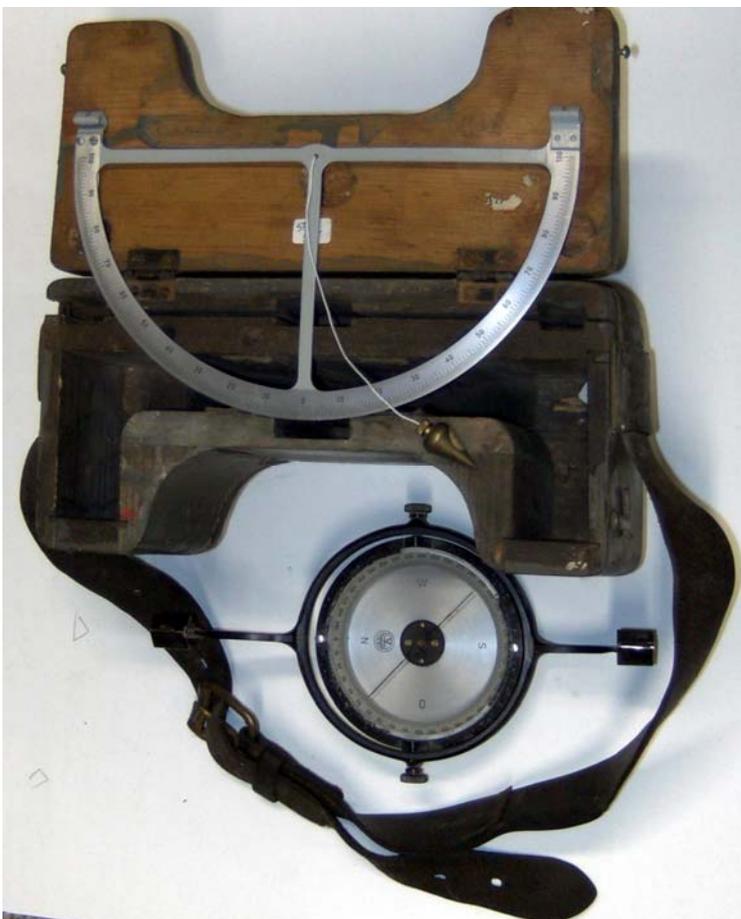
This line level with a very low weight hangs usually on a stretched line. It can also hang in the middle of a non stretched line, but for this it is not heavy enough.

The hooks are bent not both in the same direction.



The MINING SURVEYORS used an inclinometer hanging on a STRETCHED line, to show the angle in the mines. See Wolf's PLUMB BOB NEWS 2009-03 MINING page 35

Usually this inclinometer was used in combination with a compass



## B 11 PLUMB BOBS ON THUMB STONES etc.

The oldest marble carving I have spotted depicting plumb bob type 1 and Terazi dates 1746. The tools are significantly older.

Very often the plumb bobs (usually type 1 and 5) are shown on monuments or tomb stones of masons or architects, as some pictures from Elias Zacharopoulos show.

Pictures right: from IPPEIO, island of Mytilini, “Architect Frangisk(kos) Asomatia(nos)”.

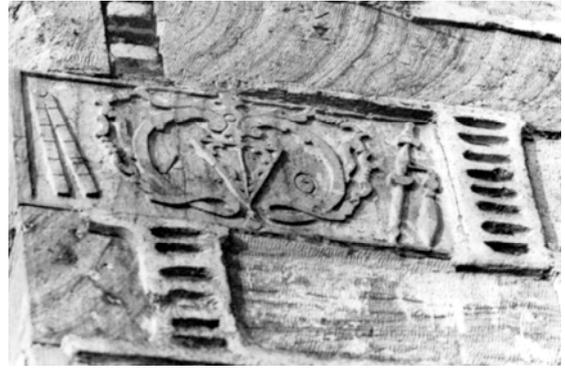


Pictures right:  
Relief from AGIASSOS,  
island of Mytilini / Greece.  
“Vassilios Hadjiemmanuel,  
Architect 1870”,  
Very clear to see a plumb  
bob type 1 and type 5  
TERAZI





ARCHITECT ANDREAS  
FILIPPIDIS  
TO HIS MEMORY 1857 MARCH



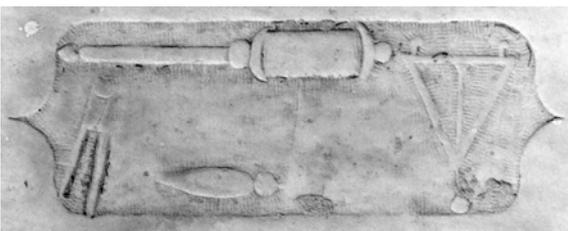
CORNERSTONE



PLATEIA VILLAGE, IN TINOS ISLAND 1829  
AUGUST 9



CORNERSTONE ISLAND  
OF LESVOS, GREECE



Marble tombstone in the cemetery of Plateia village in Tinos Island, Greece:  
THIS TOMB BELONGS TO KALFA GIORGI IN YEAR 1811- MARCH 2

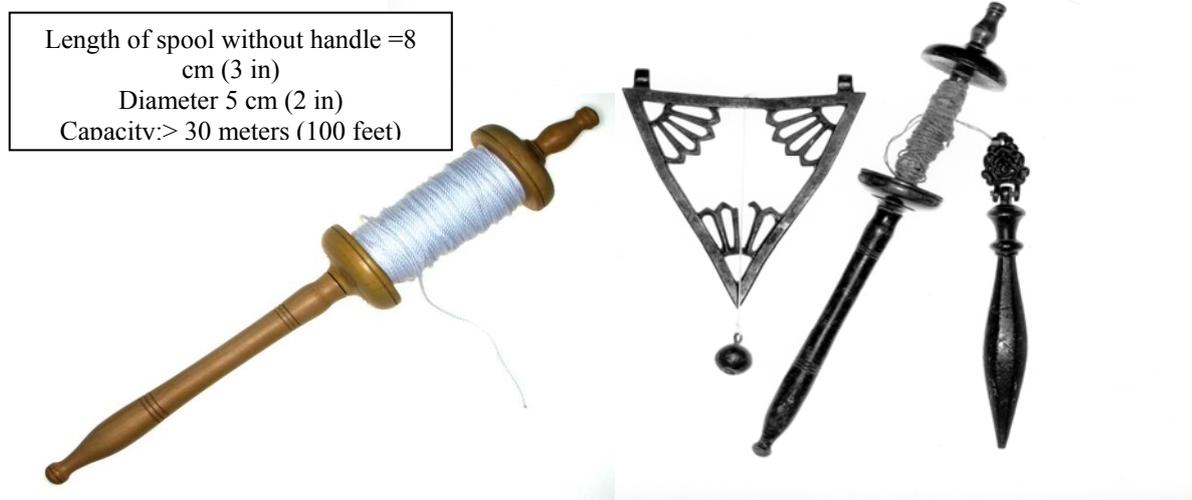
## B 12 ADDITIONAL INFORMATION

As additional tool the masons and architects used a wooden spool to wind up the line.

Elias Zacharopoulos made a test with his reproduction of the wooden spool/reel: The spool/reel can contain up to 40 meters of a 1.5 mm braided silk line. The 40 meters were the maximum used by the water pipe surveyors, mentioned in the book from Andreossy 1828.

“EZ”: *“In all the marble reliefs I have spotted the reel attached to a plumb bob. However, why should not the same line be used to suspend a t̄erazi? A plumb bob is not frequently used to check a height of 30 meters, so such a length of line for a single use seems superfluous...”*

Below a reproduction of the wooden spool and some original tools from “EZ”



## C CONCLUSION

Anatolian/Ottoman plumb bobs show a different philosophy of design and construction from their western counterparts most dramatically exemplified in Types 1 and Type 5 (Terazi):

- Their basic design concept is very simple and has remained unchanged for a very long period of time measured in centuries.
- Their construction was “hand made” by generalist metal workers, usually in brass, individually crafted for a mason, a carpenter or a surveyor and were certainly not mass produced in any contemporary sense of that phrase. Seldom does one find duplication of exact size, weight or decoration. Their construction might be considered somewhat crude, at least by today's standards.
- High emphasis is placed on the decoration of the plumb bobs in a very individualistic way. In some cases, one could say that the decorative elements limit the general utility of the tool.

If you have any questions, or if you know other details about these very interesting Ottoman Plumb Bobs, please let me know.

Thanks

Wolf Ruecker “WR”

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## D SUPPLEMENT for the Fellow Collectors from France (*en français*)

### CONSTANTINOPLÉ

ET

### LE BOSPHORE

DE THRACE,

PENDANT LES ANNÉES 1812, 1813 ET 1814,  
ET PENDANT L'ANNÉE 1826,

AVEC UN ATLAS

CONSISTANT DE SIX PLANCHES GRAVÉES, ET DE QUATRE FASCICULES LITHOGRAPHIÉS,

[Géométrique - Français]

PAR M. LE COMTE ANDREOSSY,

Lieutenant-Général d'Artillerie, ancien Ambassadeur de France à Londres, à Vienne et à  
Constantinople, de l'Institut d'Égypte et de celui de France (Académie des Sciences),  
Membre de la Chambre des Députés, etc., etc.

AZ 2

PARIS.

Traité par M. BARBOIS et M. DUPRAT, rue Haute-fenille, n° 28.  
J. S. MERLIN, quai des Augustins, n° 7, près le pont Saint-Michel.

MDCCCXXVIII.

1828

CHAPITRE VI.

*Du Tèrazi ou Niveau.*

Les détails dans lesquels nous sommes entrés sur la conduite des eaux qui abreuvent Constantinople et ses faubourgs, font voir que leur ensemble embrasse

le milieu du douzième siècle. Voyez ses *Annales*, livre XII, chap. 16, page 25.

CHAPITRE VI.

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une étendue de terrain assez considérable. Les sources les plus éloignées que l'on a dérivées sont à plus de six lieues des portes de Constantinople. Le terrain où sont placés les réservoirs et les conduites d'eau est fortement accidenté. Le pays que les cours d'eau naturels parcourent est très-boisé; il devait l'être bien plus encore à l'époque des grands travaux que nous avons essayé de décrire. Ces travaux ont été dirigés avec d'autant plus d'habileté, que des opérations de nivellement étaient fort difficiles à conduire à travers un pareil pays. On est parvenu à les exécuter, en employant, sans nul doute, un instrument appelé *tèrazi* (1), dont la simplicité antique augmente l'intérêt des ouvrages auxquels il a présidé; instrument qui est encore en usage à Constantinople, tandis que le niveau d'eau n'y est point connu. Nous allons décrire le *tèrazi* (2), ainsi que la manière de s'en servir. On jugera que s'il est d'une application moins étendue que le niveau d'eau, il peut être utile dans plusieurs circonstances où il serait impossible d'opérer avec ce dernier.

Le *tèrazi* n'est autre chose que le niveau de maçon renversé; c'est-à-dire, ayant son sommet en bas, et en haut sa base, à laquelle sont fixés symétriquement deux crochets, qui servent pour le suspendre à un cordeau que l'on tend avec soin. La pratique de cet instrument consiste à faire correspondre au milieu du cordeau le milieu de la base du *tèrazi*, à laquelle est attaché un fil à plomb; et l'une des extrémités du cordeau étant fixe, faire baisser ou lever

(1) *Tèrazi*, mot persan et turc, signifie balance, équilibre.

(2) Voyez un dessin de cet instrument, planche IV de l'Atlas.

l'autre extrémité jusqu'à ce que le fil à plomb, sa directrice, et le milieu du cordeau soient dans le même plan vertical perpendiculaire à celui du cordeau. Dans cette situation, les points de suspension sont de niveau; et il n'y a plus qu'à mesurer les différences en hauteur qu'ils indiquent. Quant à ces différences, au lieu de les écrire, les fonteniers grecs les portent successivement sur une petite ficelle qu'ils roulent autour des quatre derniers doigts de la main gauche, serrant fortement avec le pouce et l'index l'endroit de cette ficelle qui marque la dernière différence de niveau; on développe ensuite la ficelle, on mesure, et l'on a la différence de niveau totale.

Les cordeaux avec lesquels on exécute à Constantinople les opérations de nivellement sont en soie tressée. Leur longueur est ordinairement de quinze à vingt toises. Il sont terminés par des boucles, qui servent à les soutenir sur la partie supérieure de deux voyans taillés en mantonnets. Ces voyans, divisés en pieds et pouces, aident en outre à reconnaître et mesurer les différences de niveau.

On conviendra qu'il serait difficile de trouver un instrument moins casuel, plus simple et plus portatif que le *tèrazi*. Les procédés qu'il exige n'entraînent non plus aucun embarras. Si à raison du peu de longueur du cordeau, ils obligent de faire un plus grand nombre de stations, d'un autre côté ils donnent les distances à mesure qu'on procède aux détails des opérations, ce qui certainement n'est pas sans quelque avantage.

Deux nivellements du même terrain exécutés à Constantinople, le 4 juin 1814, l'un avec le *tèrazi*, l'autre avec un niveau d'eau que j'avais fait construire, ont donné à peu de chose près le même résultat.

Sous les Romains, du temps de Vitruve, qui fut l'architecte d'Auguste, les méthodes et instruments pour niveler étaient très-imparfaits, comme on en peut juger par ce que Vitruve lui-même en a dit (1). On ne sait point si un siècle après, lorsque Frontin était intendant des eaux et des aqueducs de Rome, l'art de niveler avait fait plus de progrès. Tout porte cependant à croire que la pratique n'en était pas très-sûre (2): « Les anciens, dit l'historien de l'Académie des Sciences, n'ont pu se dispenser de se servir du « niveau pour les grandes conduites d'eau qu'ils ont « faites; mais comme leur niveau était très-imparfait, « ils étaient obligés de prendre pour ces sortes de « conduites beaucoup plus de pente qu'il ne fallait. « Présentement, grâce aux niveaux inventés par « MM. Picard, Huygens, Roëmer, de La Hire, on a « vu des miracles de ces instrumens (3). »

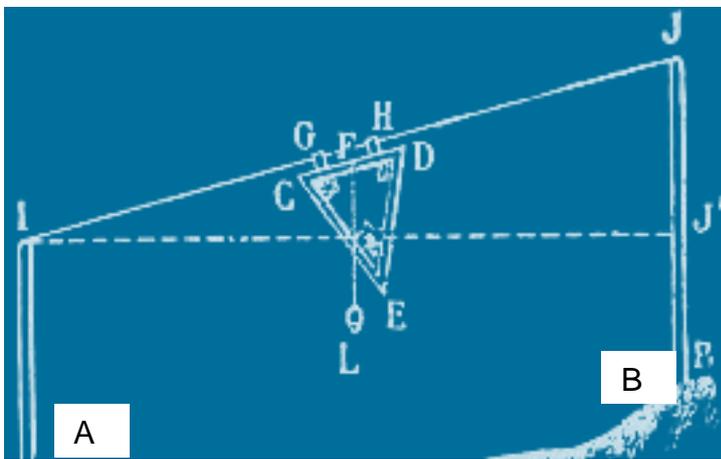
L'on juge par là que nos instrumens pour niveler n'inspiraient pas non plus beaucoup de confiance jusqu'au moment où les grandes entreprises d'hydraulique, comme celles du canal de Languedoc et la conduite des eaux de Versailles, déterminèrent en France le perfectionnement de ces instrumens. C'est entre ces deux époques qu'on a commencé à se servir du *tèrazi*, qui est dû vraisemblablement aux Grecs du Bas-Empire. Nous ne saurions indiquer l'époque pré-

(1) Voyez le chapitre de l'architecture de Vitruve, intitulé *De perductionibus et librationibus aquarum et instrumentis ad hunc usum.*

(2) Voir Raphaël Fabretti, dans ses dissertations *De aquis et aqueductibus.*

(3) *Mémoires de l'Académie des Sciences*, pour l'année 1690.

cise de son invention, dont il n'existe aucune trace, ni dans les livres turcs, du moins dans ceux qui sont venus à notre connaissance, ni chez les historiens du moyen âge.



from <http://vulgum.org/spip.php?article751> (en fait ne sont plus disponibles

)

**Le tèrazi [1] ou niveau à cordeau de Beha-Eddin (16e s.).** - Dans son *Essence de calcul*, l'auteur syrien BEHA-EDDIN (1547-1622) décrit un niveau à cordeau ou tèrazi, qui était également connu du polonais STRUMIENSKI (1573) ; cet instrument était encore le niveau préféré des fontainiers de Constantinople au commencement du 19e siècle.

Soient deux points A et B dont il s'agit d'évaluer la différence de niveau. On plante en A et B deux jalons AI et BJ de longueur égale et dont on vérifie la verticalité au moyen du fil à plomb. Entre I et J on tend un cordeau au milieu duquel on suspend par deux crochets G et H un triangle isocèle CDE en métal ajouré ; au milieu F de la base de ce triangle est fixé un fil à plomb FL. Si le fil passe par le sommet E de CDE, le cordeau IJ est horizontal et les points A et B sont au même niveau ; s'il coupe au contraire l'un des côtés, CE par exemple, on baisse l'extrémité J du cordeau jusqu'en un point J' pour lequel FL passe par E : on n'a plus qu'à mesurer JJ', qui représente la différence de niveau cherchée.

Quand il s'agit du nivellement composé, c'est-à-dire d'une opération ayant pour but de trouver la différence d'altitude de deux points éloignés en procédant de proche en proche à l'aide de nivellements intermédiaires simples, les fontainiers de Constantinople opèrent comme suit. Au lieu d'écrire les différences successives obtenues, ils « les portent sur une petite ficelle qu'ils roulent autour des quatre derniers doigts de la main gauche, serrant fortement entre le pouce et l'index l'endroit de cette ficelle qui marque la dernière différence de niveau ; on développe ensuite la ficelle, on mesure et on a la différence de niveau totale » (Andréossy).

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Les notes :

[1] Tèrazi, mot persan et turc qui signifie balance, équilibre.

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