

WOLF'S PLUMB BOB NEWS 2009

Issue 04 April 01, 2009

HYPSONETERS (with plumb bob)

Editor: Wolfgang Ruecker

TREE HEIGHT MEASURING INSTRUMENT (Hypsometer) with plumb bob.

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Dear Fellow Collector,

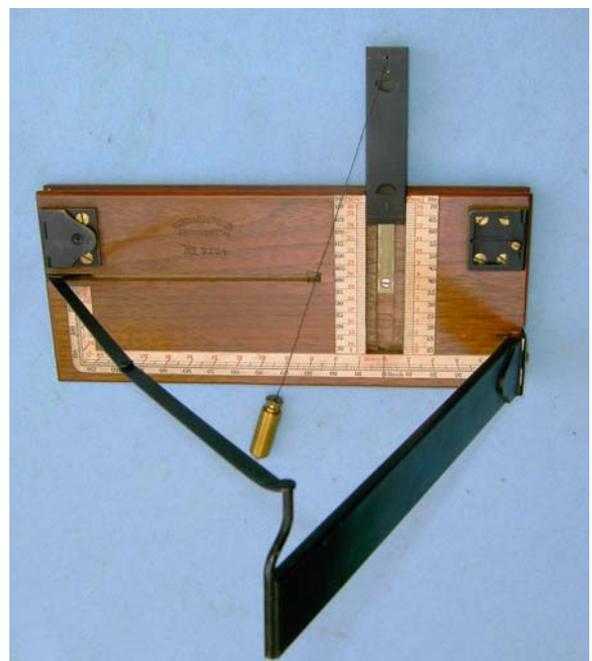
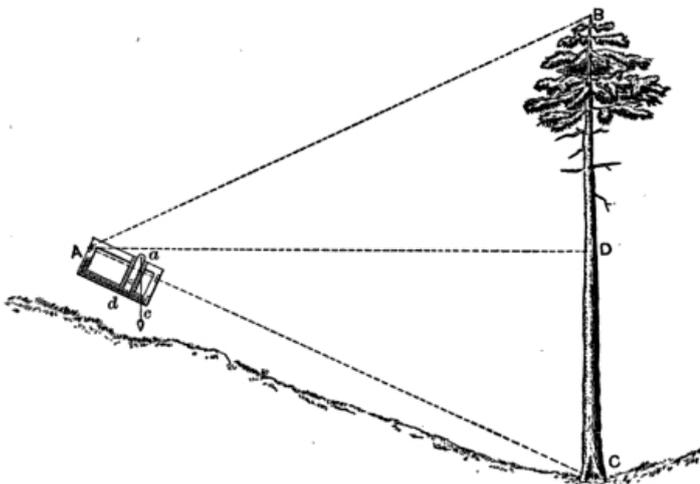
Over the years I have collected a number of inclinometers, some of which, especially designed for measuring the heights of trees are, called "hypsometers". Of special interest to the plumb bob collector are those that employ the plumb bob as part of their design.

Although there is a vast amount of information of interest on this subject including several distinct types of instruments, these examples that will be covered in future newsletters. This issue will introduce you to this subject by exploring in detail one single type, "Faustmann's Mirror Hypsometer".

Remark:

If you spot one of these instruments anyplace in the world I would be especially pleased to know about it. Of special interest would be those found in the United States.

Thank you
Wolf



1. INTRODUCTION

Before the foresters cut stands of timber they must decide exactly which trees are to be cut and determine the number of board feet of lumber that will be harvested. In basic terms this computation involves, counting the number of trees to be cut, measuring their diameters, and determining their approximate height. This computation is an essential component of “Forest Management”.

A number of formulae have been proposed to simplify the quantification of timber, and to estimate the economic benefit.

Faustmann's formula gives the present value of the income stream for forest rotation. It was derived by the German forester *Martin Faustmann* in 1849. The *rotation problem*, deciding when to cut down the forest, means solving the problem of maximising Faustmann's formula.

$pf(T)$ = value of forest at time T
 $f(T)$ = stock of timber at time T
 p = price of timber
 r = discount rate

The formula says

$$PV = pf(T) \exp(-rT) \cdot (1 + \exp(-rT) + \exp(-2rT) + \dots) = \frac{pf(T)}{\exp(rT) - 1}$$

A theorem ensues: **Cut the forest when the time rate of change of its value is equal to interest on the value of the forest plus the interest on the value of the land.**

☺ Don't be afraid, I will not explain this formula, today. Rather, today's Newsletter will focus on the INSTRUMENTS themselves and the MEASURING METHOD to determine a tree's height.

There are many sophisticated instruments to determine the vertical height of things to a high degree of accuracy. However, accuracy costs dearly in the time it takes to set up these sophisticated, expensive and delicate instruments. Foresters need SIMPLE, SMALL, LIGHT, INEXPENSIVE instruments to speed up their work needing only an approximate degree of accuracy.

A forerunner in the field of FOREST MANAGEMENT was the German, Martin Faustmann, who in 1856 invented a tree height measuring instrument. He called this device, “FAUSTMANN'S MIRROR HYPSONETER”.

One of Faustmann's friends, the editor of a well known FOREST JOURNAL “Allgemeine Forst- und Jagdzeitung”, published in Frankfurt Germany, gave him the chance to introduce his “Mirror-Hypsometer” in the December edition, 1856 on **9 pages** of this journal. Faustmann explained the disadvantages of the instruments already in use up to that time, and then goes into detail why his invention was better. He also, explains in detail the parts of his invention and describes the procedure for using his mirror hypsometer to best advantage. (I bought copies of these pages from the publishing house and can send it on demand.)
(Fig. right) Use of the US-Version of the Hypsometer 1908¹

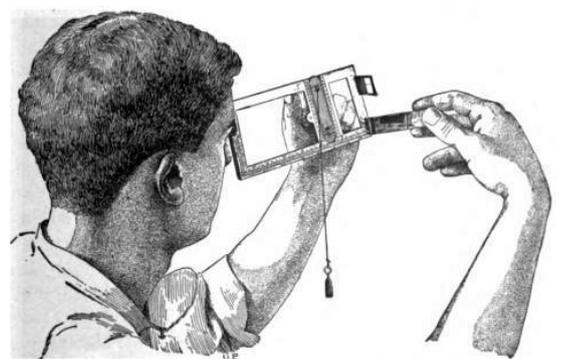


FIG. 3. — Manner of using Faustmann's height measure. (Graves, Bulletin 36, Forest Service, United States Department of Agriculture.)

Biography of Faustmann:

Born feb. 19, 1822 in Giessen Germany

University Giessen, Forester in Babenhausen.

Died feb. 1, 1876 in Babenhausen / Darmstadt Germany

No picture of him is known!

¹ Handbook of Forest Mensuration of THE WHITE PINE in Massachusetts 1908

2. TREE HEIGHT MEASURING

(Statements from different sources that describe the details and the method of measuring with hypsometers). This is like a puzzle with 500 pieces ☺

- ² "... For measure the **diameter** was used a "**caliper**" 36 inch, 30 oz and for measuring the diameter of very large trees a **circumference tape** is recommended This is a steel tape so graduated that when placed in a position encircling the tree trunk, the diameter at that point may be read directly" (see fig. right from ³)
- ⁴ **HYPSONETERS**: The next commonest instrument for measuring trees is the hypsometer, an instrument for measuring heights; and since it is employed almost **exclusively for measuring the heights of standing trees**, the term has been defined by the committee on terminology "**an instrument for measuring heights – especially of trees.**" Hypsometers are of many styles and kinds, but they all depend upon the geometric principle of **similar triangles**, or upon the trigonometric principle of tangents.
- ⁵ one of the hypsometers is the **FAUSTMANN**: This instrument, **made originally in Germany**, but also made in this country (USA) under patent rights, consist of a **metal frame** (or, in the cheaper models, a **rectangular board**, about 7 inches long and 3 ¼ inches wide...
Remark Wolf: I didn't find a patent and don't believe that it exists.
- ⁶ **The Measurement of the Height of Trees** is made by means of instruments called hypsometers or dendrometers, of which here are many different kinds, and **the simplest are the best for work in the woods**. They all ascertain the height by means of the relative proportions of equal-angled triangles. Most of the methods in practical use require a base-line to be measured from the stem to the point of observation; and the instruments of this sort which have proved most convenient for use in the Continental woods are König's Measuring-Board, Hossfeld's Hypsometer, Faustmann's Mirror-Hypsometer, and Weise's Telescope-Hypsometer, - and especially the last named. ...
- ⁷ ... **Faustmann's Mirror-Hypsometer** is a small instrument, mostly made of very light wood, which can be folded and put in a stiff paper case (about 7 in long, 4 in broad, and ½ in thick) for carrying in the pocket. The distance of the observer from the tree having been measured, the movable upright arm is set accordingly. When short (0-15 yards, or multiples of 0-15 ft.) the end of this marked II, is adjusted on the right-hand scale, to form the similar triangle; while for longer distances (15-30 yards, or multiples of 15-30 feet the end marked I is set against the scale on the left-hand side representing the number of yards between the observer and the stem. In this handy little instrument the observation is made through an aperture in a small metal disc, at one end, and by a hair-line stretched across a metal frame at the other end. (see fig. right from ⁸) This hypsometer **can also be used for aligning forest roads, marking out drains, and the like**. It costs only about 5s.....



FIG. 63.—Calipering a tree.



FIG. 65.—The mirror hypsometer in use.

² FOREST MANAGEMENT NY USA 1919 p 32

³ PRINCIPLES OF AMERICAN FORESTRY NY USA 1908 p190

⁴ FOREST MANAGEMENT NY USA 1919 p 32

⁵ FOREST MANAGEMENT NY USA 1919 p 33

⁶ THE FORESTER John Nisbet LONDON ENGLAND 1905

⁷ THE FORESTER John Nisbet LONDON ENGLAND 1905

⁸ PRINCIPLES OF AMERICAN FORESTRY NY USA 1908 p192

- ⁹ *The Faustmann Height Measure.* – This instrument, shown in Fig. 16 (right, below) consists of a skeleton rectangular **metal frame** having two cross-bars at one side of its longitudinal center, the frame and bars being in one piece. A **slide**, reversible end for end and having beveled edges, works in **undercut grooves** formed in the inner edges of the cross-bars. This slide is provided at its ends with **thumb notches**, and with transversely arranged **index marks**, designed I and II. A **plumb line carrying a plummet** is attached to the slide in the center of the index mark II. A **retaining spring** secured to the back of the frame and bearing against the inner face of the slide holds it in any position in which it may be set. The left-hand end-bar of the frame is furnished with an **eyepiece**, and the right-hand end-bar with an **objective**, both of metal, and **hinged** so as to be **folded down** out of the way when the device is not in use. A **long, narrow mirror** is hinged to the frame at a point below the objective, so as to reflect a right-hand **horizontal scale** and a left-hand horizontal scale engraved upon the lower bar of the frame, and meeting a zero-point, which is intersected by a line passing through the longitudinal center of the slide. ... The scales are divided in fifths and numbered. The lines forming the scales are equally separated from each other and represent units of distance under any system of measurement that may be adopted. The **handle** of the device is attached to the left-hand cross-bar. A **cheaper form** of the instrument has a **solid wooden frame and slide**, and the scales are stamped on inlaid white composition. ...

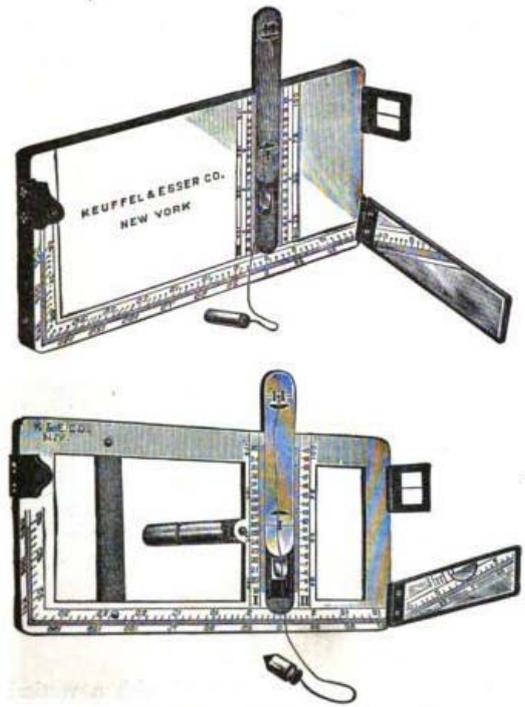


FIG. 16.—The Faustmann Height Measure.

- ¹⁰ *The Faustmann height measure is compact, light, and well adapted for rough work.* The only delicate part is the mirror, which folds against the face to the instrument; it is not apt to be broken except by very careless usage. It is **extremely accurate** when used by a trained hand. With practice one should **be able to measure trees** not over a hundred feet high **within a foot** and those not over 50 feet high **within 6 inches**. When the instrument is in constant use, it is necessary to renew the thread frequently, as it is apt to become frayed and cause inaccurate reading. It is difficult to use the instrument in a strong wind, because the plumb-line is light and easily moved. **For general forest work where accuracy is desirable, but great precision is not necessary, the Faustmann height measure give the most satisfactory result.**
- ¹¹ *Practice has demonstrated that the use of a plumb-bob and weight reduces the serviceable character of the instrument, since the seweights are easily lost and the strings broken. The mirrors also are easily damaged.*
- ¹² *The Faustmann “mirror hypsometer” is a clever little instrument by which the observer may get the height of trees by simply pacing the distance from its base to the point where the treetop is in line with an eye piece and a hair line set six inches away. The treetop appears to the observer, a slide is moved up to the figure corresponding to the distance, a plummet swings over a scale, and the figure it covers, reflected by a mirror to the observer’s eye, is the tree’s height. This convenient tool does away with computations, and enables the user to accomplish much in a short time.*

So far the statements in different English and American books.

⁹ FOREST MENSURATION Henry Solon Graves NY USA 1908

¹⁰ FOREST MENSURATION Henry Solon Graves NY USA 1908

¹¹ FOREST MENSURATION Herman Haupt Chapman NY USA 1921

¹² THE TREE BOOK Julia Ellen Rogers NY USA 1906

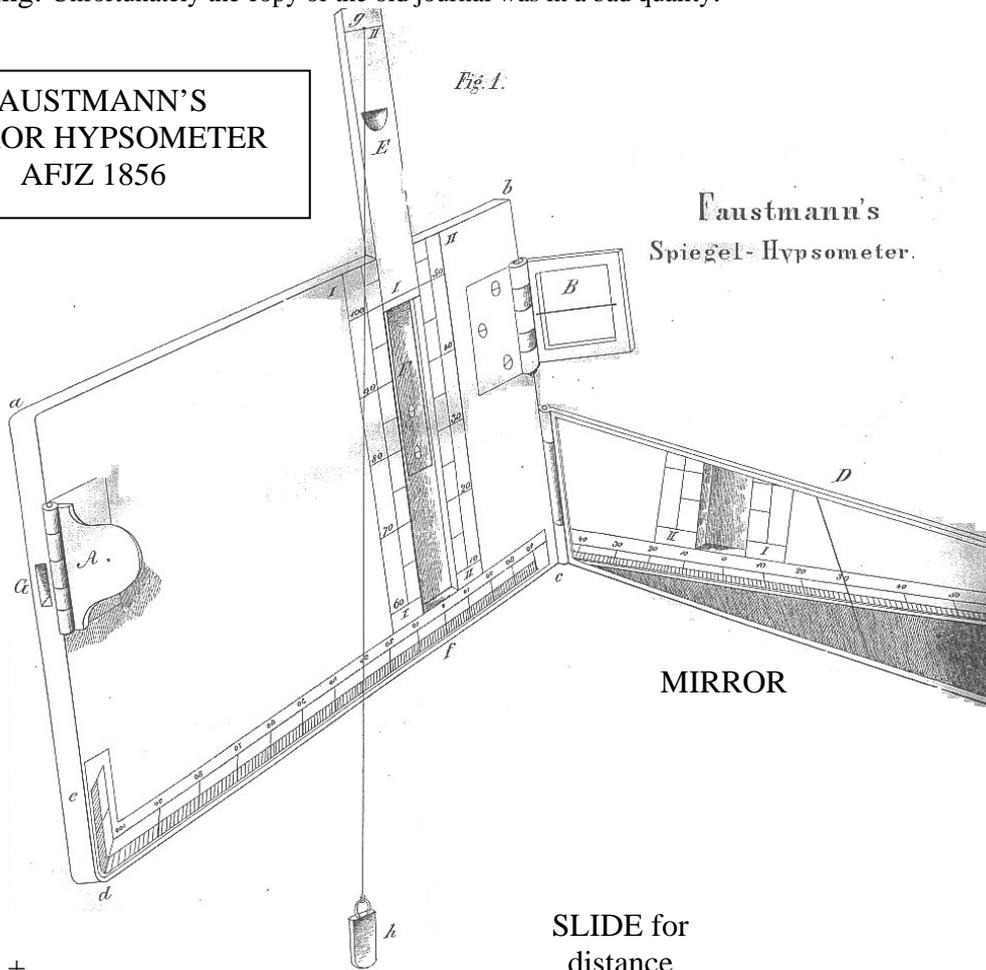
3. FAUSTMANN'S MIRROR HYPSONETER

The **original drawing** of his instrument in the AFJZ 1856¹³ with some modifications made by me for a better understanding: Unfortunately the copy of the old journal was in a bad quality:

FAUSTMANN'S
MIRROR HYPSONETER
AFJZ 1856

Fig. 1.

Faustmann's
Spiegel-Hypsoneter.



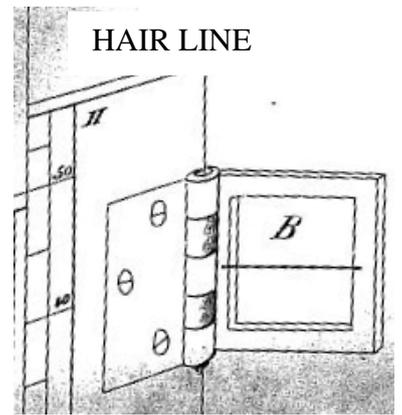
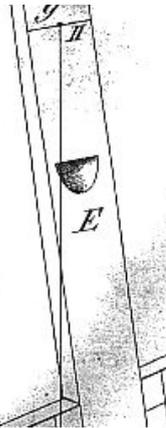
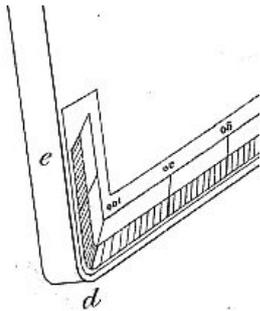
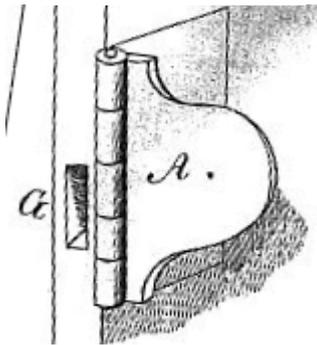
EYEPIECE +
STORAGE for
plumb bob

SLIDE for
distance

SCALE

PLUMB BOB

HAIR LINE



Before I started to write this article I thought that the Faustmann's Mirror Hypsoneter was used only in Germany and Austria. I was concerned about translating all the special terms from German into English. But my search in the www and Google.books¹⁴ showed me, that this instrument was known and used all over the world. In America it was offered for many years by Keuffel & Esser N.Y. in their catalogues (details below). Thus, I was able to use information from English speaking sources.

¹³ Allgemeine Forst- und Jagdzeitung Dec 1856

¹⁴ www.books.google.com

4. AMERICAN CATALOGUES

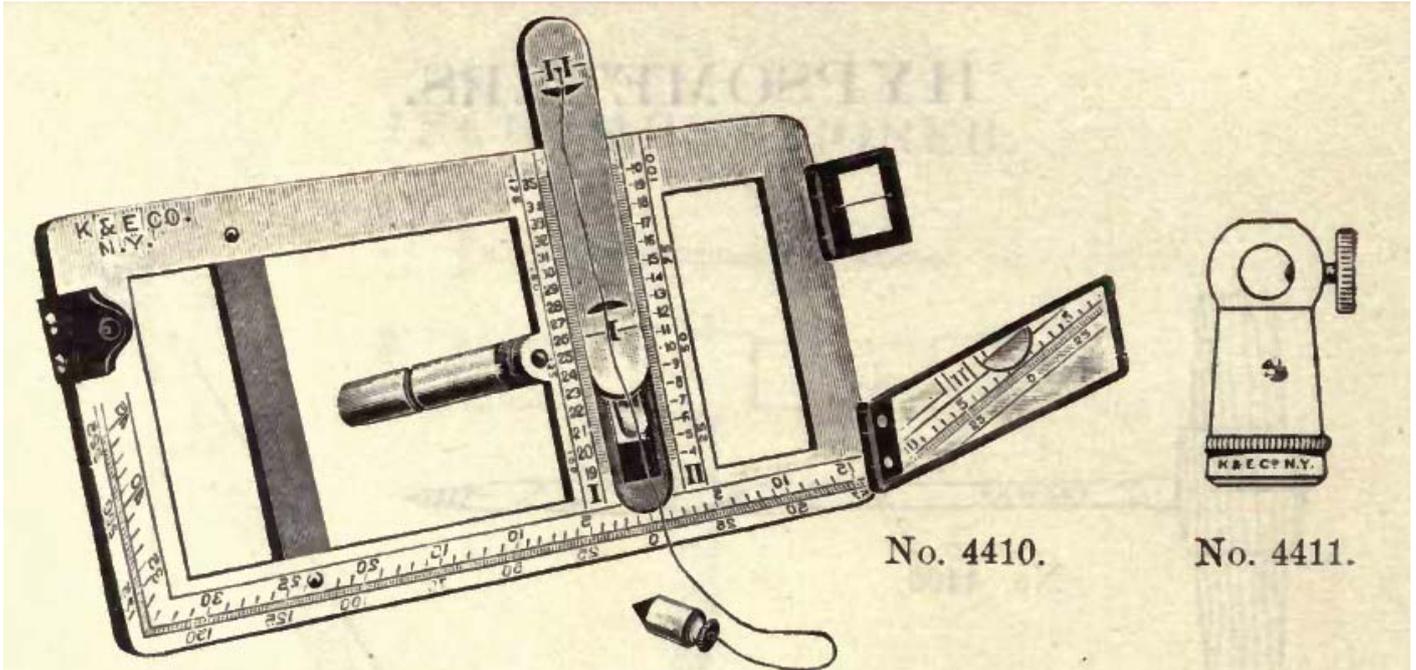
KEUFFEL & ESSER NY USA

(Thanks to all Fellow Collectors who sent information and scans of the K & E catalogues).

In America the Faustmann Hypsometer was offered by K&E in all their catalogues between 1904- 1936. I find it curious that it doesn't appear in America for a full 50 years after its invention in 1856. The disappearance of this instrument in catalogues seems to coincide with WW II, no doubt corresponding to the cessation of trade with Germany during the war years.

In all catalogue issues except 1936, we find 2 types: #4410 (brass frame) and #4412 (polished hardwood). In 1936 (38th edition) only the #4412 is offered. The packaging box is never shown.

THE BRASS FRAME HYPSONETER # 4410 K&E 1904

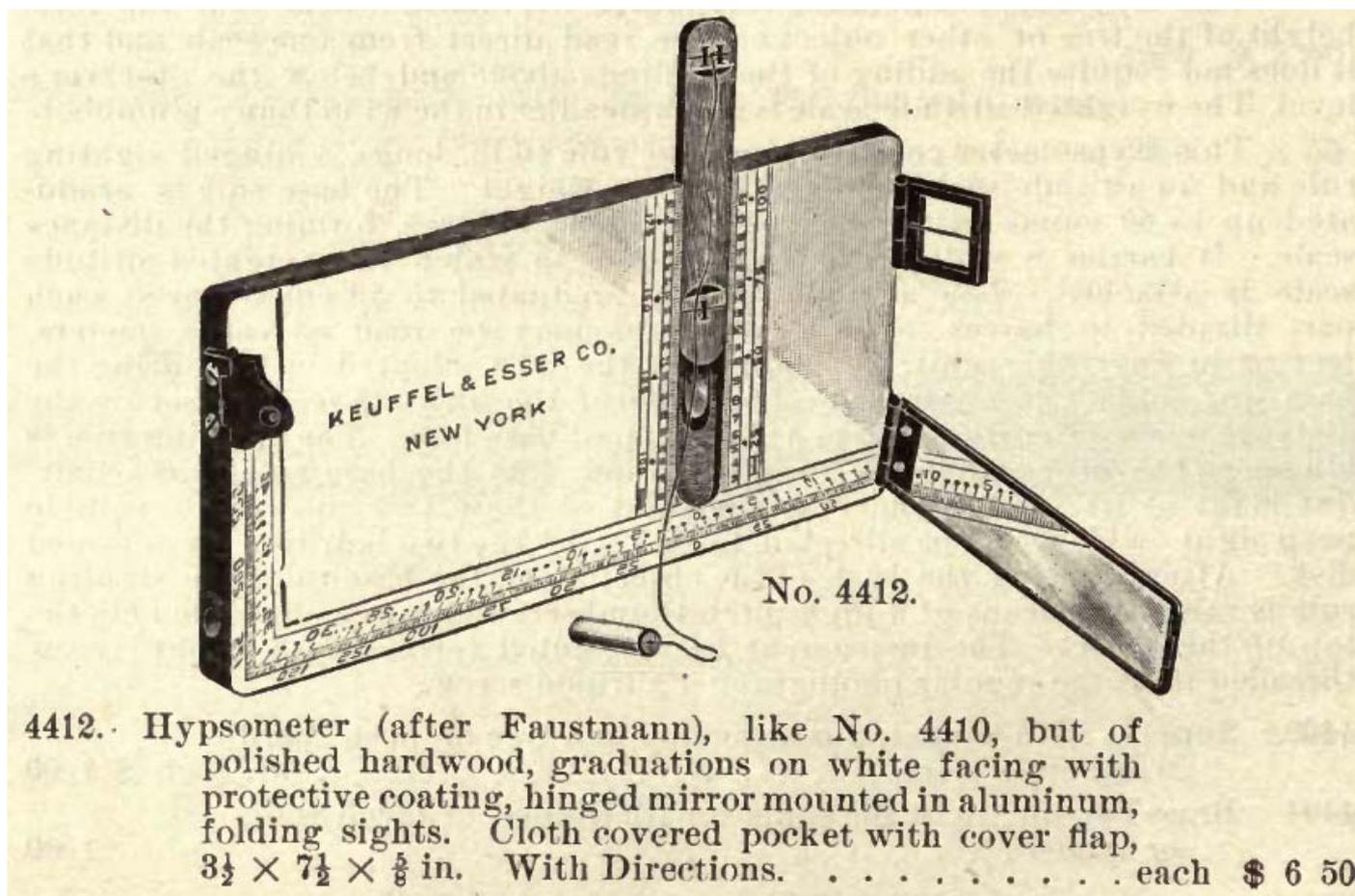


4410. Hypsometer (after Faustmann), brass, graduated surface silvered, hinged mirror mounted in aluminum, folding sights, folding swiveling handle. In cloth covered pocket with cover flap, $3\frac{1}{2} \times 7\frac{1}{2} \times \frac{5}{8}$ in. With Directions each \$19 50

This mirror-reading Hypsometer is $3\frac{1}{4} \times 7$ in. It is provided with two scales: the scale of heights on the lower edge of the instrument and the scale of distances on the two edges of the groove in which the slide moves. The slide carries the plumbbob cord and has two reading lines marked I and II, corresponding to the two scales of distances, also marked I and II. It is held in place by a spring. The plumbbob is stored in a small tube at the back of the frame. The peep-hole and hairline sights are hinged to fold down. The hinged mirror is $5\frac{3}{4} \times \frac{3}{4}$ in. The cylindrical nickel-plated metal handle on the reverse side of the instrument swivels and also folds down.

4411. Brass Ferrule, to fit the support with Gimlet, (No. 4402, pp. 5) or Jacob staff, or tripod. each \$ 1 00

(I have never seen this "BRASS FRAME TYPE". If anyone knows where such an instrument exists, please let me know. Thanks.)



REMARKS to K&E:

- K&E was established in 1866 by the German Wilhelm Keuffel and his friend Hermann Esser
- # 4410 exists only in America.
- # 4412 is similar to the European instruments.
- The drawings and text are identically for 30+ years
- Starting in 1909, the model 4410 was sold with a “sole leather Pouch” for \$ 2

Some advantages of the #4410 to the original of 1856:

- Metal frame is more durable.
- An additional handle is provided for more convenient use and to allow the instrument to be mounted on a tripod or a single leg, an extreme advantage allowing the user to steady the instrument
- The graduated scales are “silvered”, more durable than paper scales.
- Graduations on white facing have a protective coating, an improvement over paper scales.
- Mirror is mounted in aluminum instead of brass, thus reducing the weight of the instrument.

LAST MINUTE INFORMATION:

The Faustmann is also shown in the US catalogue **DIETZGEN** 1931 14th edition. (same as K&E)

5. GERMAN CATALOGUES

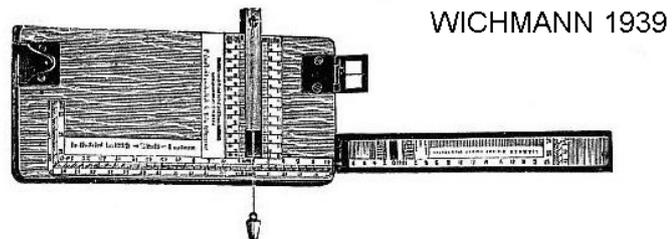
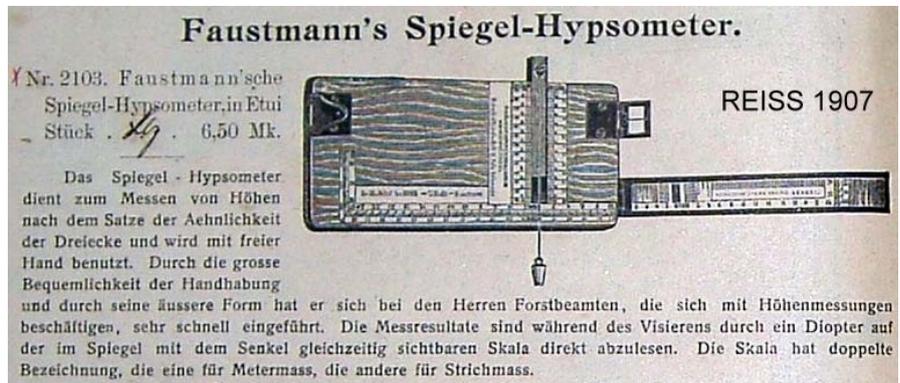
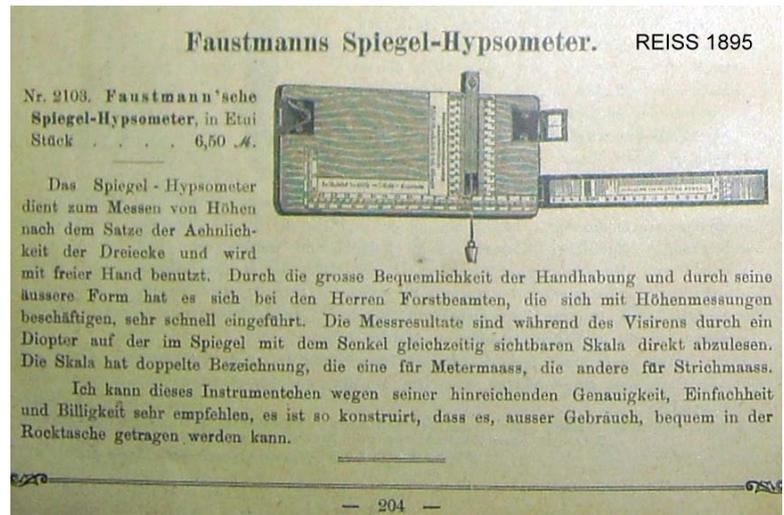
In Germany I found the Faustmann Hypsometer in Catalogues of REISS in Liebenwerda (1895 + 1907), WEILAND Liebenwerda (1928) and WICHMANN Berlin (1939)

The text is similar to the information in the American books and catalogues.

The plumb bob in the drawing is not the same found on certain examples (see below)

The drawings are the same for both companies: REISS and WICHMANN were affiliated.

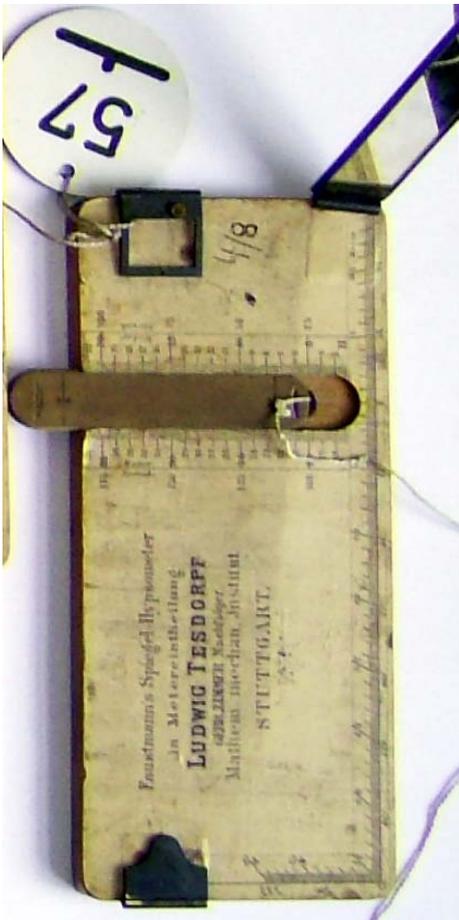
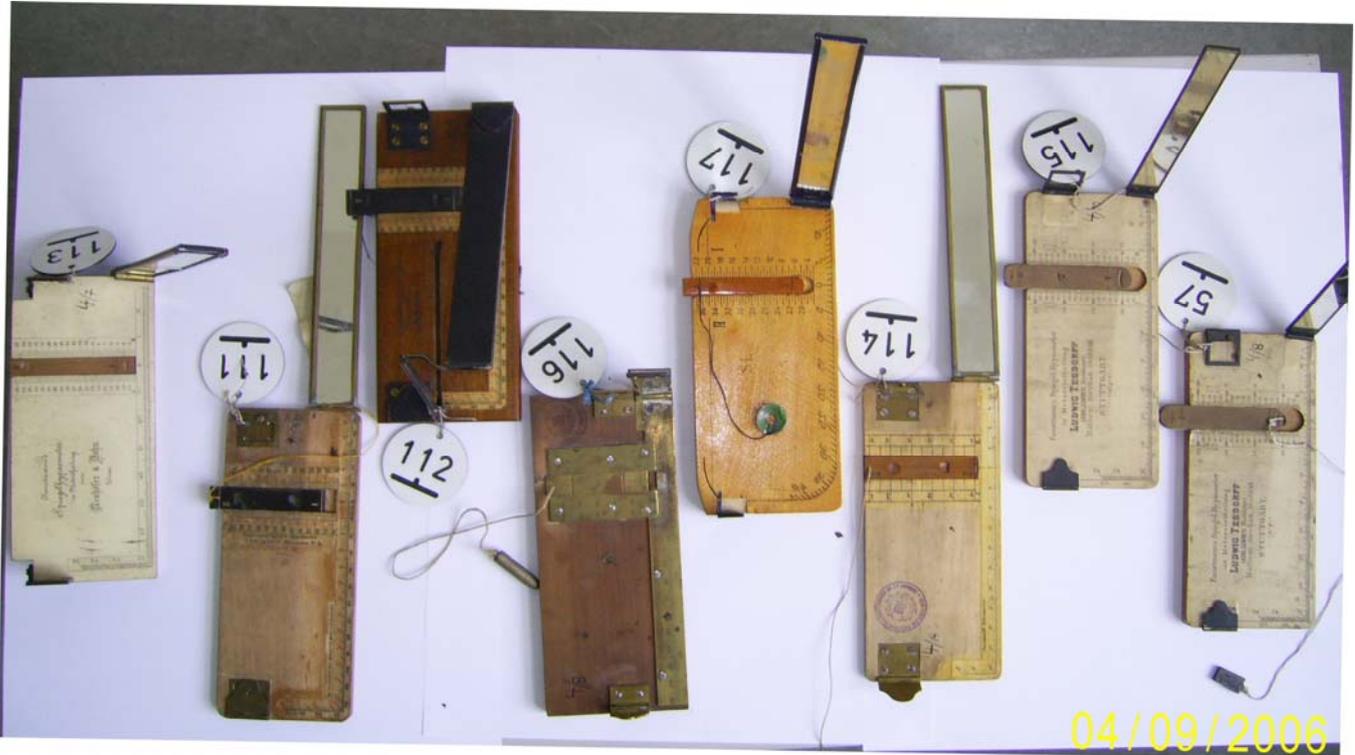
The WEILAND has a different shaped eye piece and hair line, fixed by 4 screws instead of 2 screws as on the WICHMAN examples.

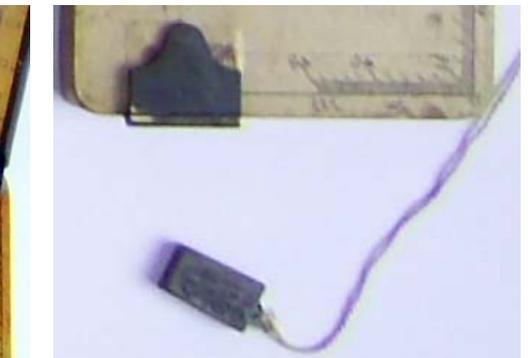
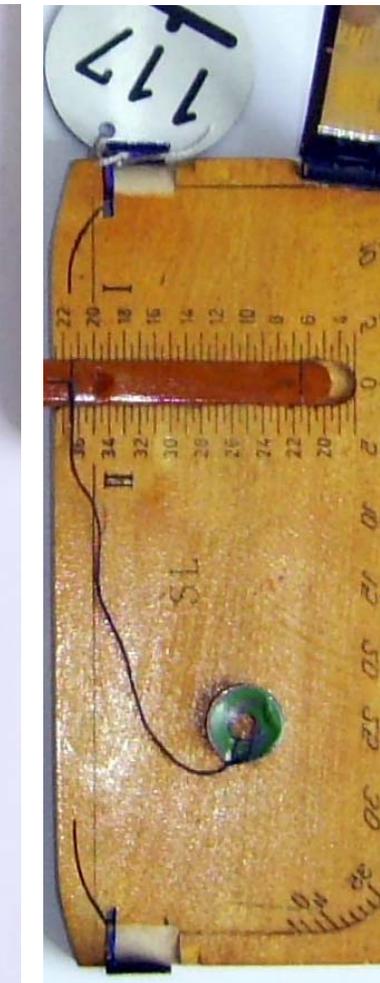
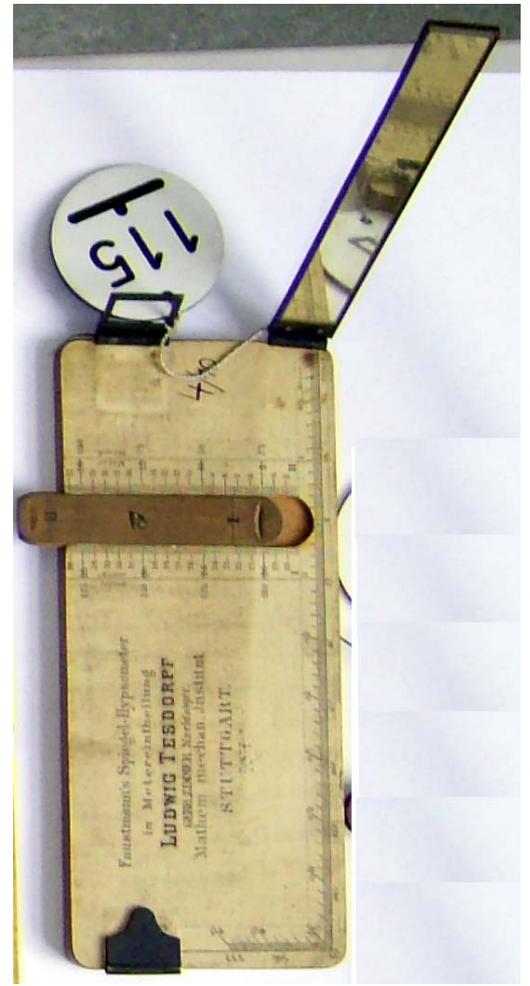
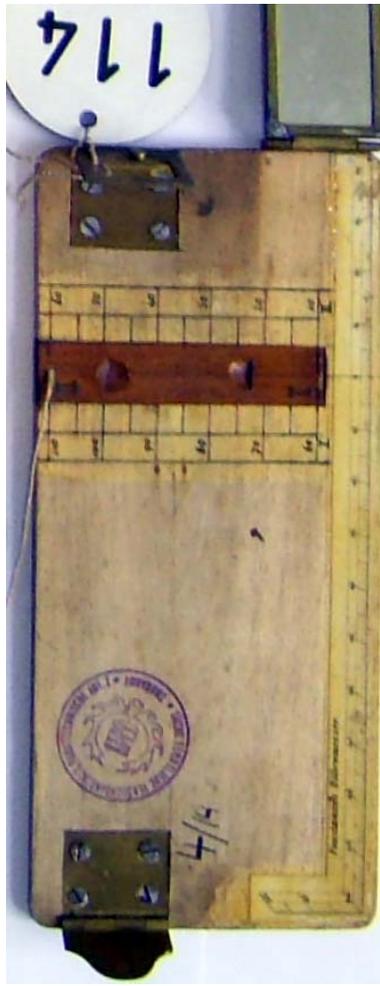
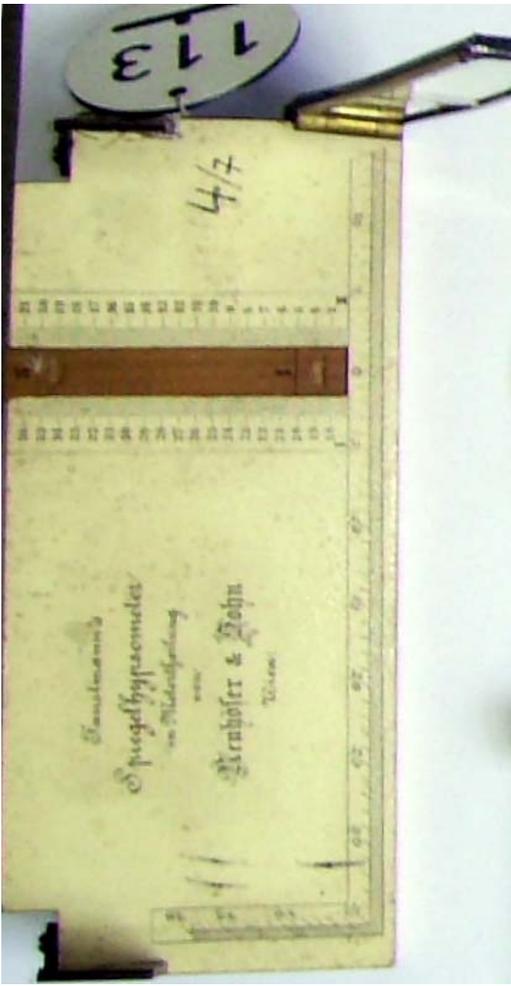


Nr. 2602 **Spiegel-Hypsometer** nach Faustmann, zum freihändigen Messen von Höhen nach dem Satze der Ähnlichkeit der Dreiecke. Durch die Leichtigkeit der Handhabung und durch seine zweckmäßige Form hat dieses Gerät sich bei Forstbeamten, die sich mit Höhenmessungen beschäftigen, sehr schnell eingeführt. Die Messergebnisse sind während des Visirens durch ein Diopter auf der im Spiegel mit dem Senkel gleichzeitig sichtbaren Skala direkt abzulesen. Die Skala hat doppelte Bezeichnung, die eine für Metermaß, die andere für Strichmaß; in Behälter **14,—** RM

6. UNIVERSITY DRESDEN GERMANY

One of the leading German Universities for Forestry is in Dresden. This was the only web site where I found a photo of a Faustmann's Hypsometer. They have in their collection, eight Faustmann's Mirror Hypsometers. In 2006 I received some photos of their examples and in 2008, visited the collection. Their examples were all well used. (Thanks to the staff. For their help and cooperation.)





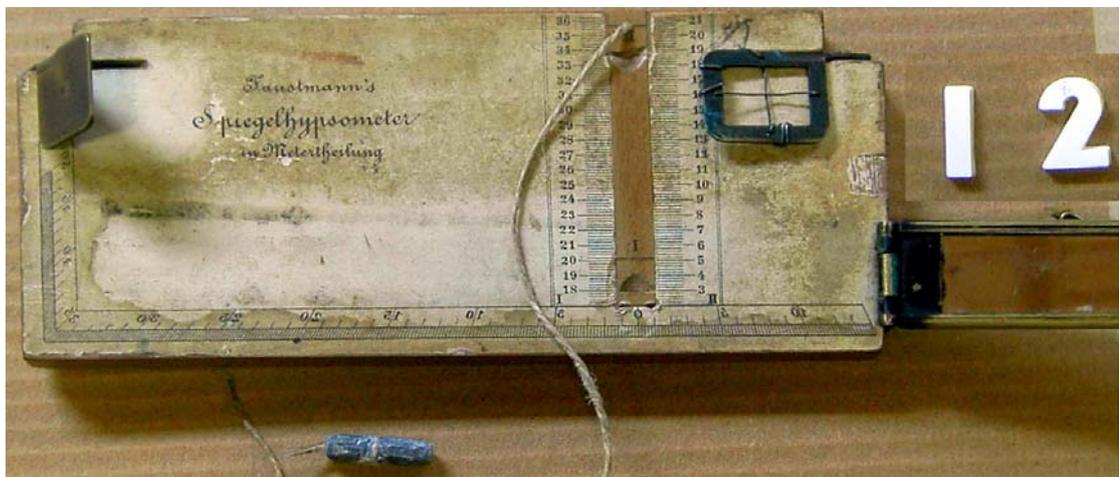
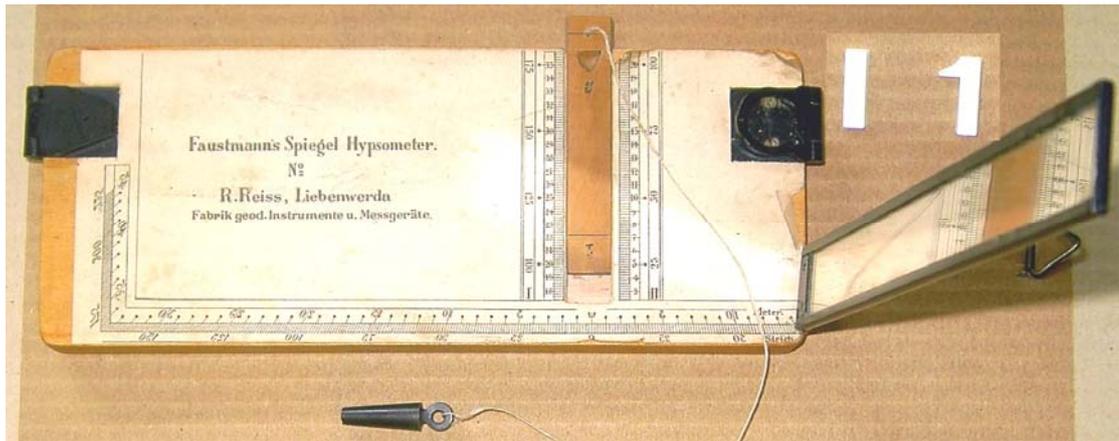
All the parameters of these instruments are available in Excel by request.

The oldest is marked with the number #114. (single marked on scale; paper scale at left is very short in length.)

Some instruments from the show cases of the university Dresden.



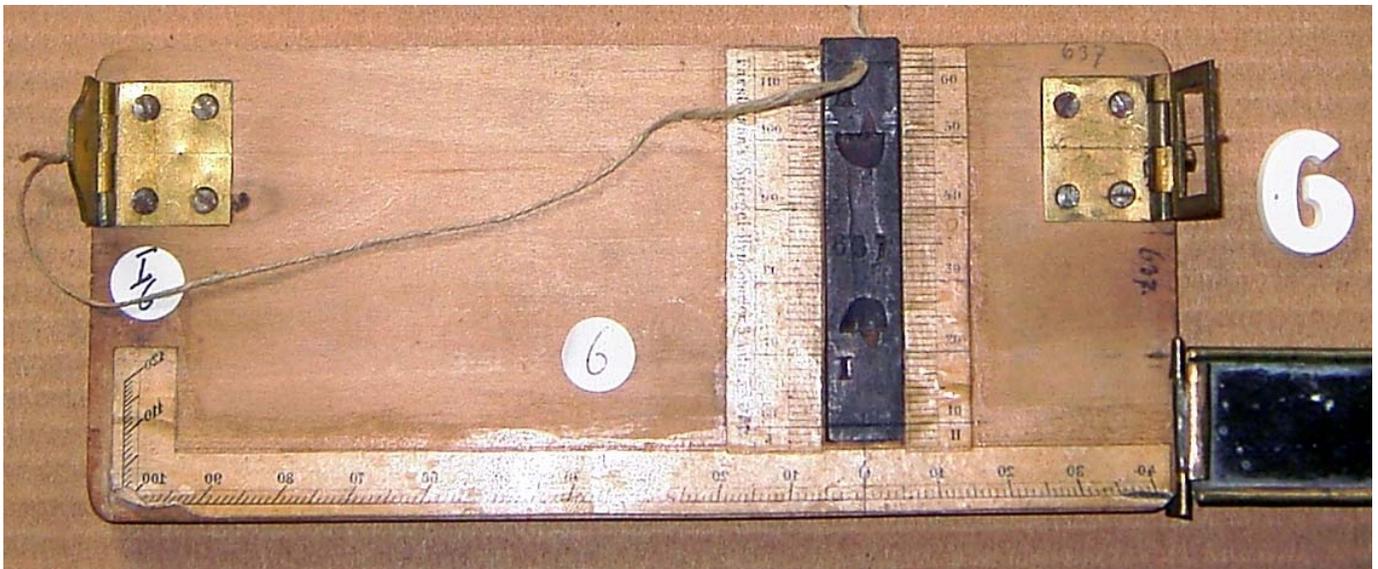
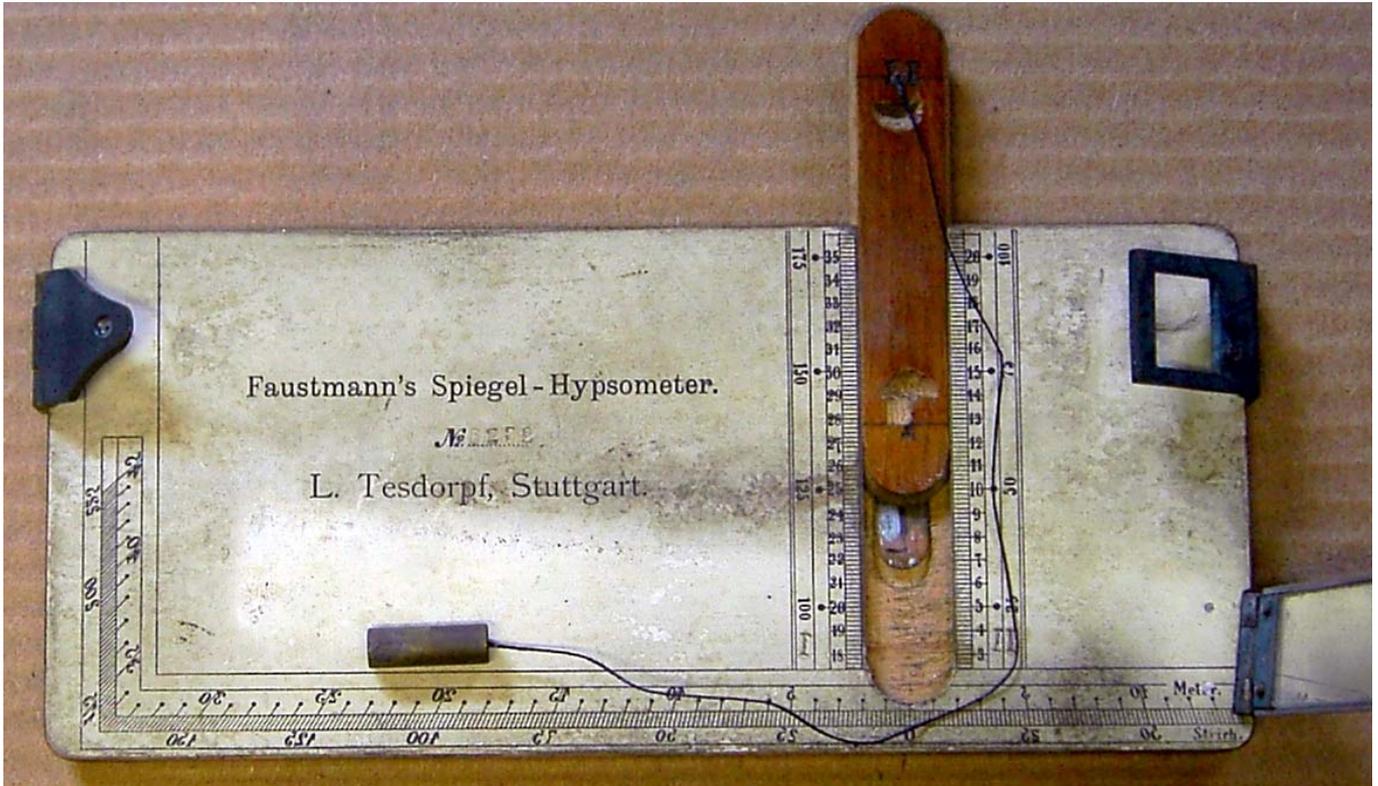
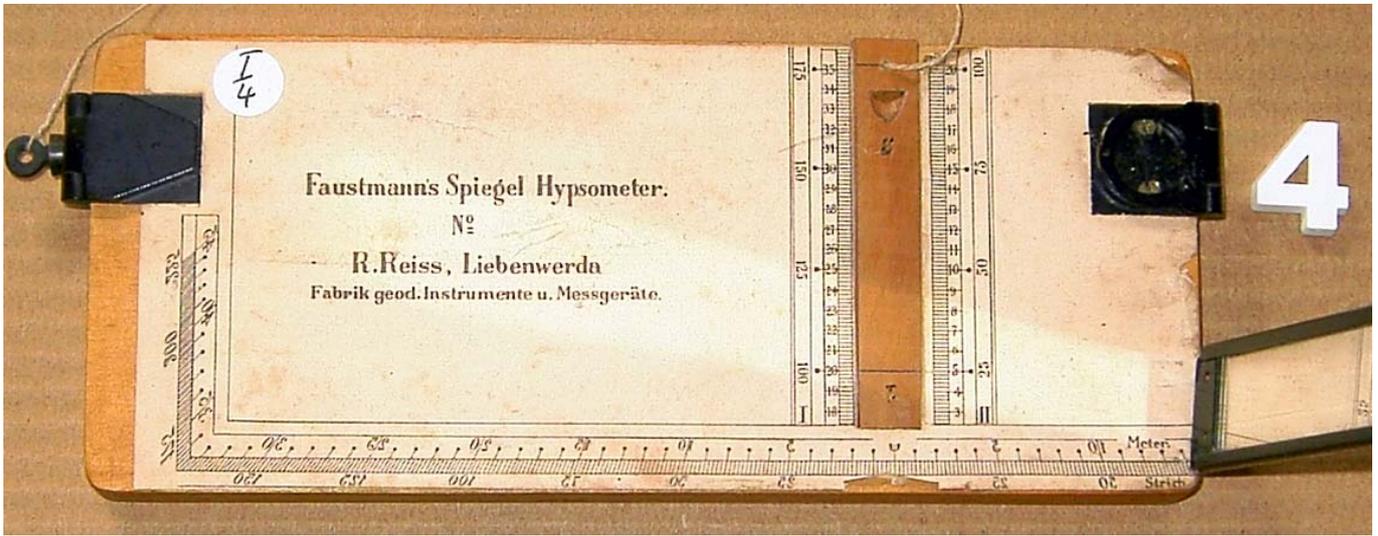
7. COLLECTION WOLF RUECKER INSTRUMENTS



In my collection I have now 7 Faustmann Mirror Hypsometers

The best example, marked # 3, was made by Hartmann & Braun, Frankfurt. (c. 1884-1890) has an especially substantial mirror mount the mirror, of extreme benefit for the user. Although this is the best example I've seen, the line was discontinued in 1890, fairly early in the history of use of these instruments.





BOXES AND BACKSIDES

Note different packaging boxes items marked from #6 to # 1



The different wooden backsides and sizes from 6 to 1.

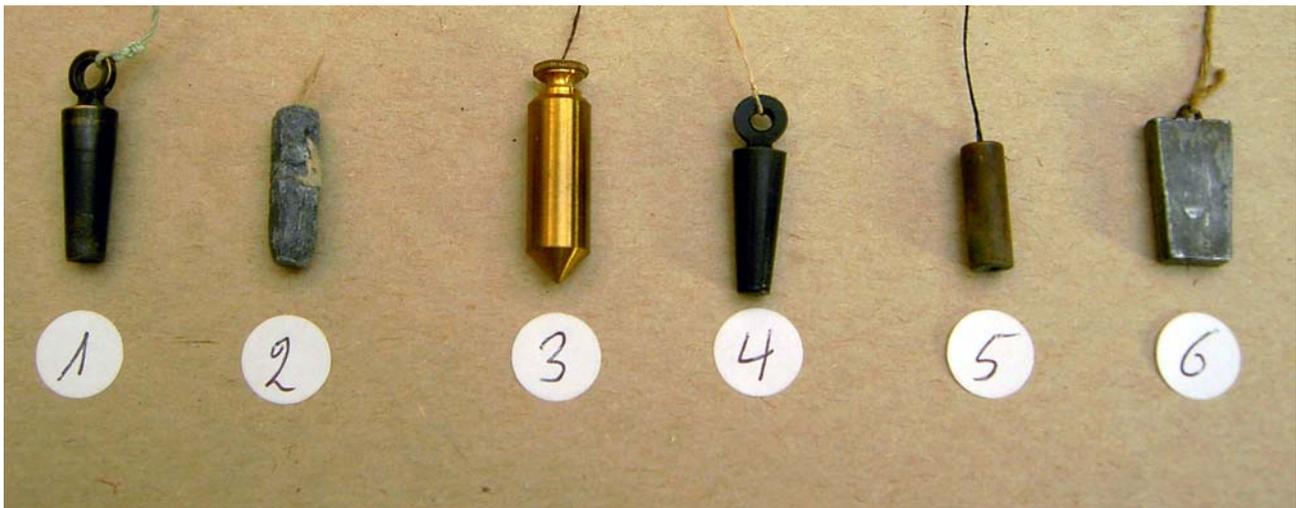


The slide of #6 is made in segments.
Note the spring in the middle for the slide.



EVOLUTION OF THE DIFFERENT PARTS

The PLUMB BOB SHAPES

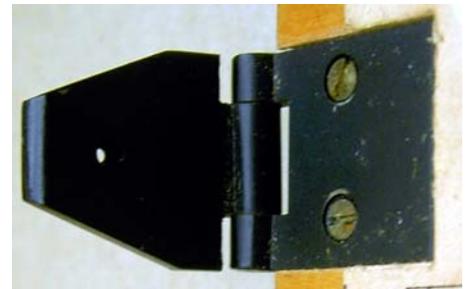


- # 1 Brass, Maker REISS (Geodetic surveying instruments), one piece. C.1900 ± 20
- # 2 Lead, cylindrical, line casted in the body. C. 1890 ± 20
- # 3 Brass, Maker Hartmann & Braun, (Scientific and electric instruments), head unscrews, (looks like # 4410 in K&E catalogues) c. 1890 ± 5
- # 4 like # 1
- # 5 Brass, vertical hole through for the line. C. 1900 ± 10 (looks like # 4412 in K&E catalogues).
- # 6 Lead, with an eye on top, (like the original plumb bob from 1856). C. 1856 to 1900

DETAILS of EYE PIECES



WR # 1 REISS



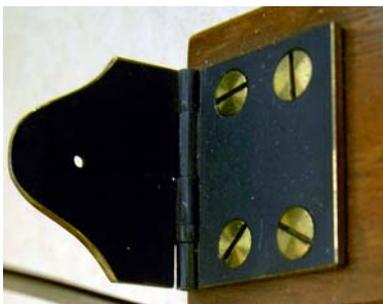
WR # 4 REISS



WR # 2 NEUHÖFER



WR # 5 TESDORPF



WR # 3 H&B



WR # 6 FAUSTMANN

**DETAILS of
HINGED MIRROR and HAIR LINE**



WR # 1 REISS



WR #4 REISS



WR # 2 NEUHÖFER



WR # 5 TESDOPRF



WR # 3 Hartmann & Braun



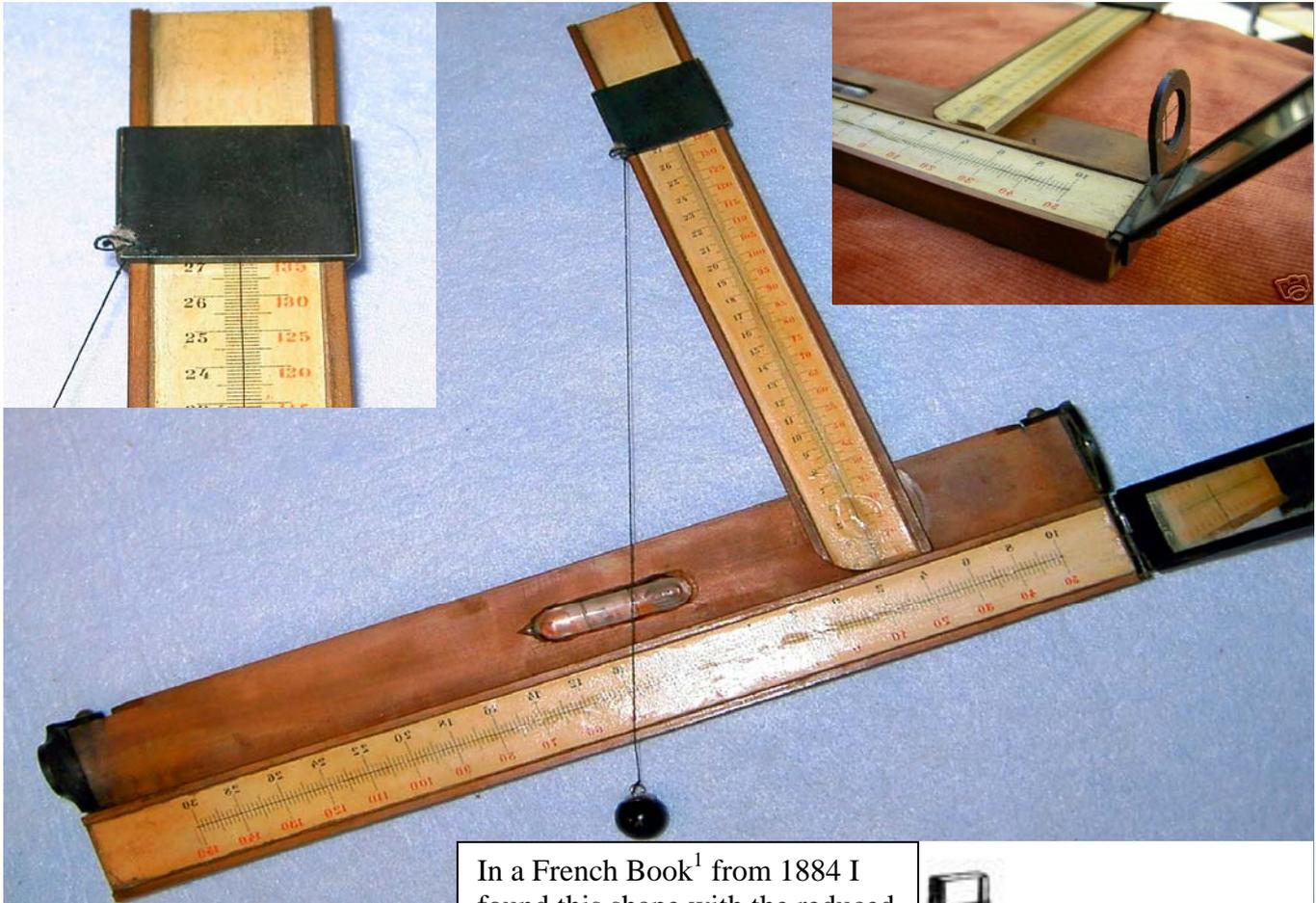
WR # 6 FAUSTMANN

Figure right:
From a Hartmann & Braun 1890s.
The plumb bob in its “garage”.
The scale with division markings
in “Strich” (black) and “Meter”
(red) . Reflected numbers.

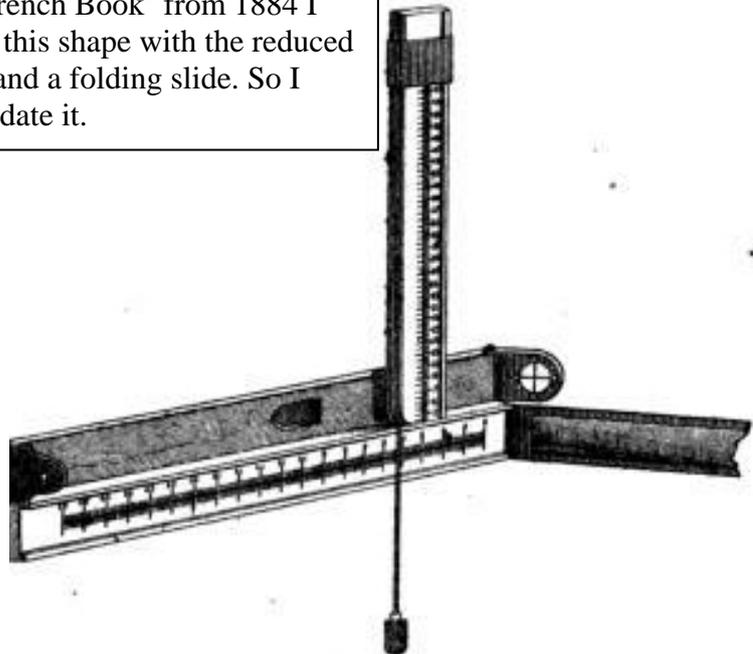
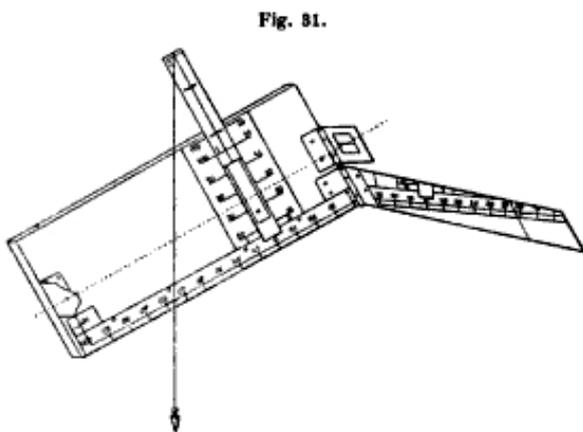


8. OTHER SHAPES

From **Hungary, in 2007, I purchases** this hypsometer made in a unique shape. The slide can be folded when not in use, so a much more compact instrument is much easier to move around. The vial glass seems not to be original. This place was reserved for the storage of the plumb bob, when not in use. (see drawing).



In a French Book¹ from 1884 I found this shape with the reduced body and a folding slide. So I could date it.



(Fig. left) In 1887 and 1912 was mentioned a modified version¹⁵. The sighting device is directly above the mirror.

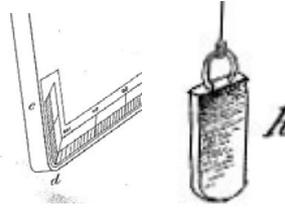
¹⁵ Handbuch Forstwissenschaft 1887

9. HOW OLD IS MY FAUSTMANN MIRROR HYPSONETER?

Short version of an estimation. (more details see in the German version of this article on www.plumbbob.de)

MAKER:

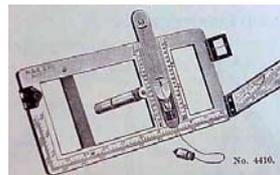
- **Martin FAUSTMANN** Germany
Shape of plumb bob see fig. right
Small paper scales
Graduation in "Strich" not "Meter"
Lower scale has a small vertical part only
Produced between 1856 and 1900



- **HARTMANN & BRAUN** Germany
Folded support between mirror and body
Scales red and black
Makers mark burned into the wood
Produced between 1884 and 1898



- **KEUFFEL & ESSER** USA
Metal frame
Handle
Produced between 1903 and 1938



- **Ludwig TESDORPF** Stuttgart Germany
Mirror hinged under 5 degrees (see fig. right)
Produced between 1881 and 1906



- **REISS** Liebenwerda Germany
Mirror hinged under 0 or 5 degrees
Shape of plumb bobs see figs. right
Produced between 1882 and 1940



- **NEUHÖFER & Sohn** Wien Austria
Special hinge (screw)
Cross hair instead of hair line
Produced between 1872 and 1907



Other makers mentioned in books (no instrument known):

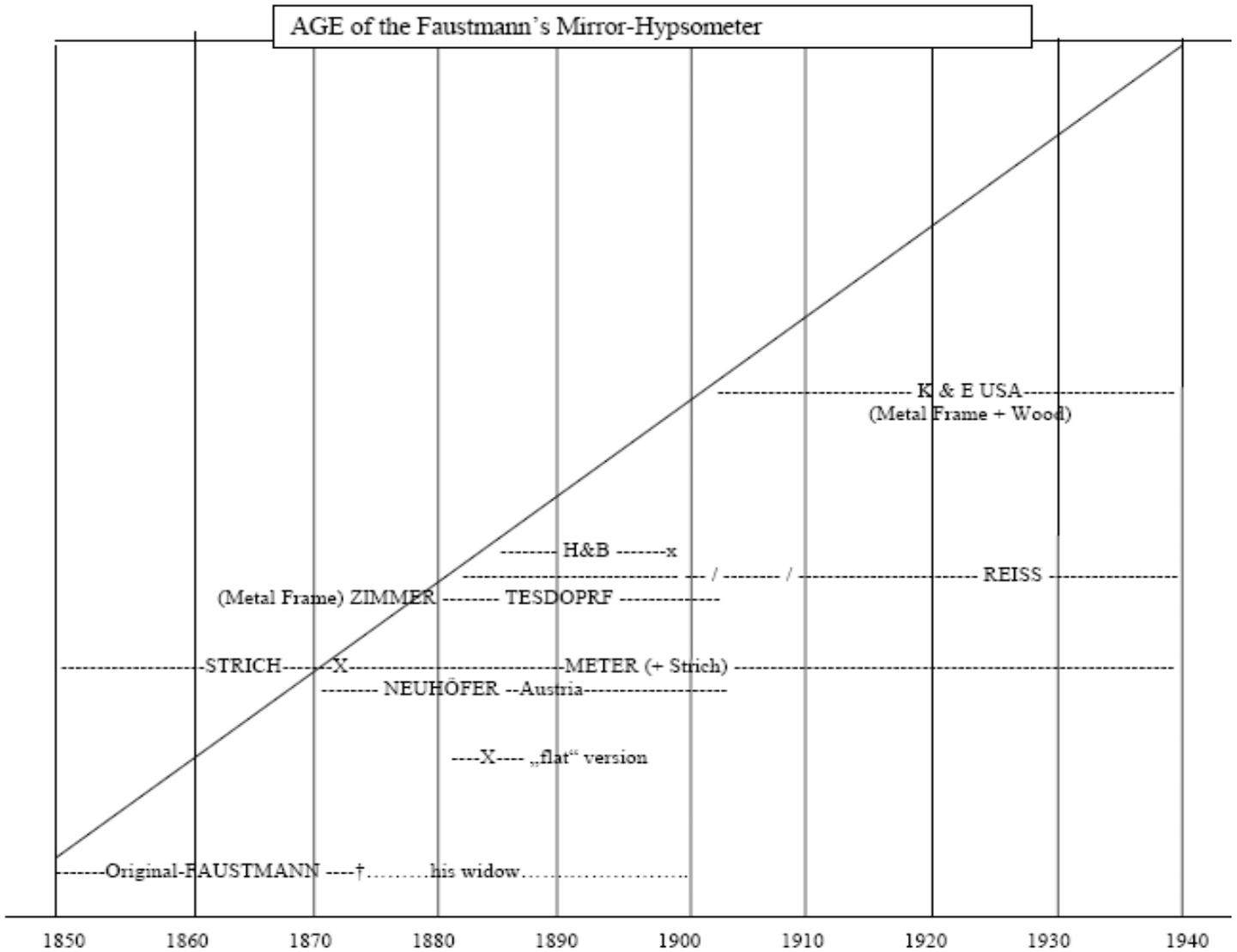
FROMME Wien Austria mentioned 1884 + 1888

SPÖRHASE Giessen Germany since 1888, mentioned 1898 + 1907

GÖHLERS Wwe Freiberg Sachsen Germany mentioned 1888

KRAFT & SOHN Wien Austria mentioned 1888

If you have a Faustmann's Mirror Hypsometer marked with a maker's name, you can estimate the age by the "AGE GRAPH" below. There are a lot of other methods, but they are too difficult for me to put it into a graph.



At least a view of the "adjustment room" (1914) for surveying instruments of the factory REISS and something to smile: Postcards from REISS (factory of surveying instruments) given to their clients.



Sorry can't see a MIRROR HYPSONETER



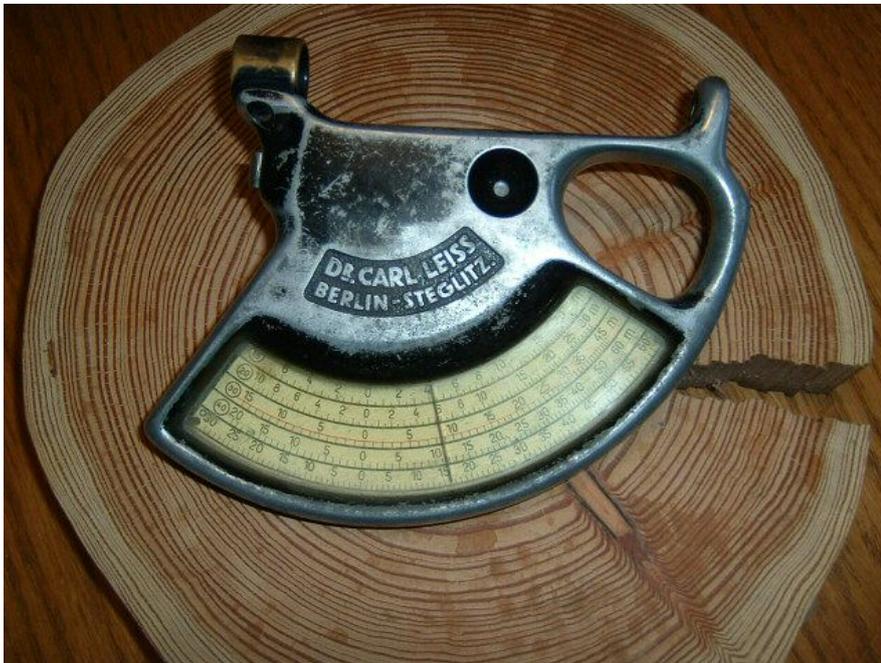
Mechanische Werkstatt — Justierraum.



10. CONCLUSION:

The foresters need a SIMPLE, SMALL, LIGHT, CHEAP instrument with a SUFFICIENT ACCURACY OF MEASUREMENT to measure the height of trees. For more than 80 years the “Faustmann” Mirror Hypsometer was such an instrument. It was simple, made of wood with a common plumb bob and equipped with screws to adjust the hinged mirror, the eye-piece and the hair-line. It was a simple, inexpensive, versatile tool, easy to tote around and simple to repair in the field as needed.

- The earliest hypsometers using plumb bobs took two people to use, one person to measure and one person to read the scale on the instrument.
- Faustmann’s invention of the “Mirror Hypsometer” allowed one man to set up and determine a height measurement.
- The disadvantages were similar to plumb bobs in general, They are affected by the wind and the occasional breakage of the plumb line. Retrieving a small plumb bob on the forest, could be very annoying.
- Thus, last in the developmental of hypsometers was an instrument with a “blocked result” after measuring the tree height. In Germany the BLUME-LEISS was a very common Hypsometer for tree height measuring after 1930



If you want to know more details about the described hypsometers, please ask.

Remark:

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Enjoy it

Wolf Ruecker