

THE INTRODUCTION OF SLIDE RULES IN SPAIN

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Summary

Slide rules first appeared and were developed in England from the sixteenth to nineteenth centuries. In the early nineteenth century, French mathematicians imported the Jones English rule to France. Lenoir began production in 1820 with this slide rule being rapidly adopted and required in schools of higher learning.

In Spain we have to wait until 1852 to clearly find an interest in this instrument; the first slide rules came from France.

This article was primarily researched using documents available on the Internet.

Foreword

We know that after the invention of the slide rule in England, by Oughtred in 1625, this instrument quickly evolved into different types with time.

Initially, engineers needed calculations for maritime navigation, duties on alcoholic beverages by the Customs, and later, those associated with the industrial revolution. These needs were the main causes for the development of rules like the Gunter, the Everard, the proof, the Coggeshall, and the Routledge or engineer's slide rules. All of these rules, created in the seventeenth and eighteenth centuries, were specialized.

In the early nineteenth century, the JONES slide rule was introduced with a more 'universal' approach; we can consider this rule as the origin of the 'modern' slide rules. This rule was 'discovered' by French scientist Jomard in a study tour conducted in England in 1815. Returning to France and with the help of the Society for the Promotion of Industry (Société d'Encouragement pour l'Industrie Nationale), he made every effort to adapt and introduce this instrument into French society.

From 1820, Lenoir, a manufacturer of precision instruments, along with Collardeau, manufactured slide rules adapted to the French market (cm instead of inches). Gravet continued Lenoir's work and, from 1867, the Tavernier-Gravet brand continued making slide rules until after the Second World War.

By the mid-nineteenth century, 4 or 5 instruction manuals had already been released in France (Collardeau, Mouzin, JF Artur,...) explaining the use of slide rules, which had become mandatory with entry exams for military and engineering schools.

Slide Rules in Spain until the mid-19th Century

One of the earliest references we have of the presence of a calculating device in Spain is in the Ioseph Zaragoza book, published in 1675 [1]. The author describes 14 mathematical instruments, including a military 'pantómetra' model specialized for the construction of fortifications. Ioseph Zaragoza was the first mathematician who published tables of logarithms in Spain [2].

During the seventeenth and eighteenth centuries, the following calculating means were used in the maritime navigation: tables of logarithms, the Gunter scale, and the pantómetra (the calculating sector or proportional compass), as documented in several books of that era:

"... Everything is only resolution of triangles either by using tables of logarithms, or with the reduction quadrant, or with the plain scale, or with the Gunter one, or with the pantómetra ...". Lecciones de Navegación para el uso de las compañías de guardas marinos, 1790.

"... I am of the opinion that said 'Pantómetra' is fabricated and graduated in Spain, so that in our nation enters the appreciation of making all sorts of mathematical instruments ..."

Antonio Valladares stated in the *Semanario Erudito*, 1789, Volume XIX.

"... In the year 1623 Gunter applied the logarithms of numbers, sinus and tangents to straight lines drawn on a rule normally 2 English foot long; this instrument in the form of a scale is commonly used daily by the Navigation and for

other purposes, and is usually called the Gunter ...". *Curso de Matemáticas para la enseñanza de los caballeros seminaristas de Madrid*, D. Tadeo Lope y Aguilar, 1798.

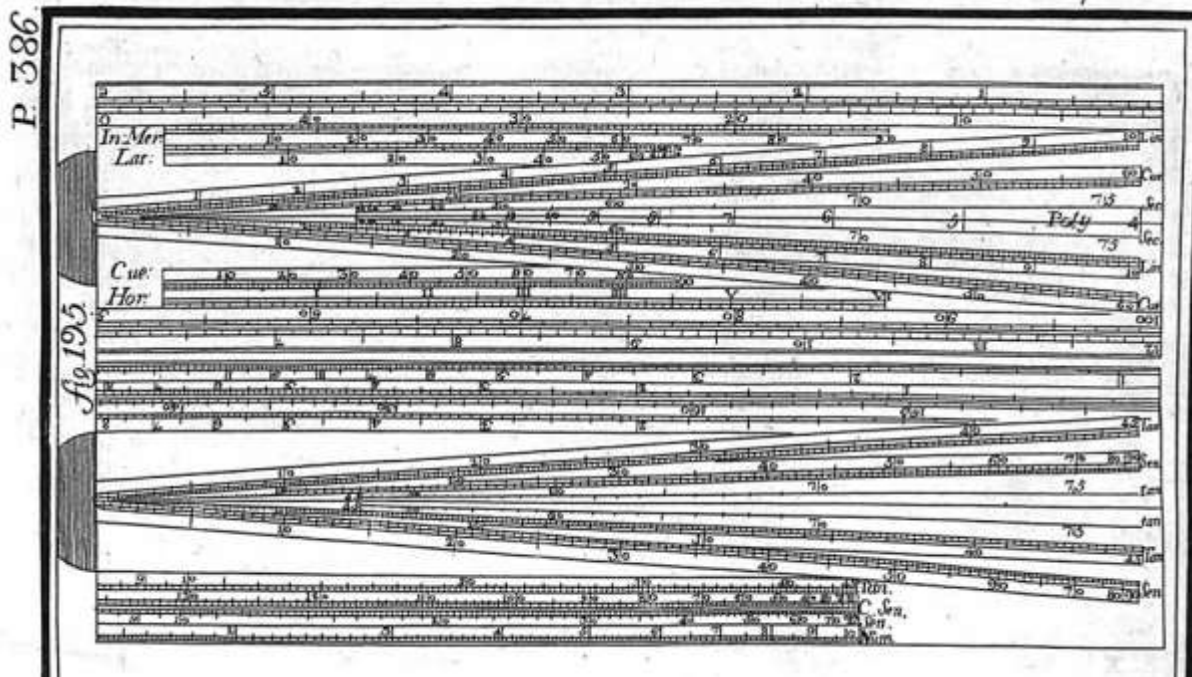


Figure 1. A Pantómetra

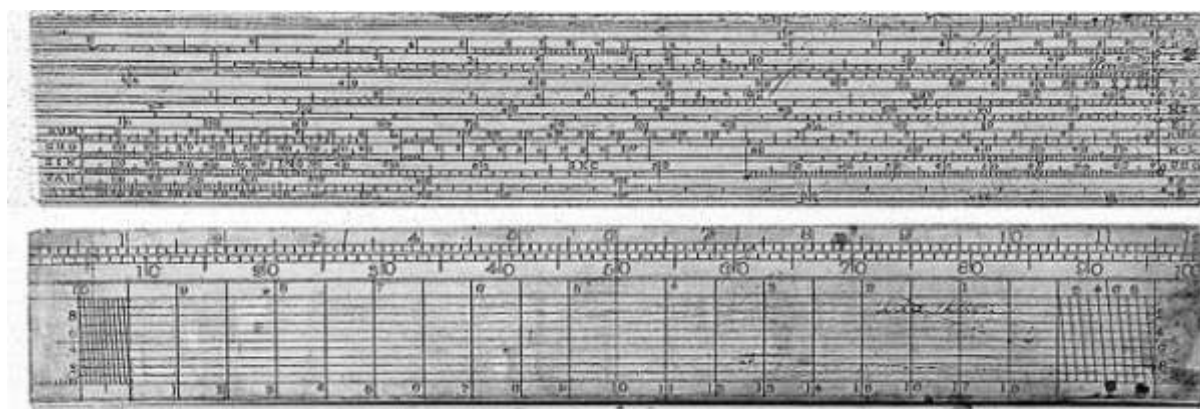


Figure 2. A Gunter Rule



Figure 3. Construction of the Lines on the Gunter Rule

CONSTRUCTION OF THE LINES ON THE PLANE SCALE, &c.

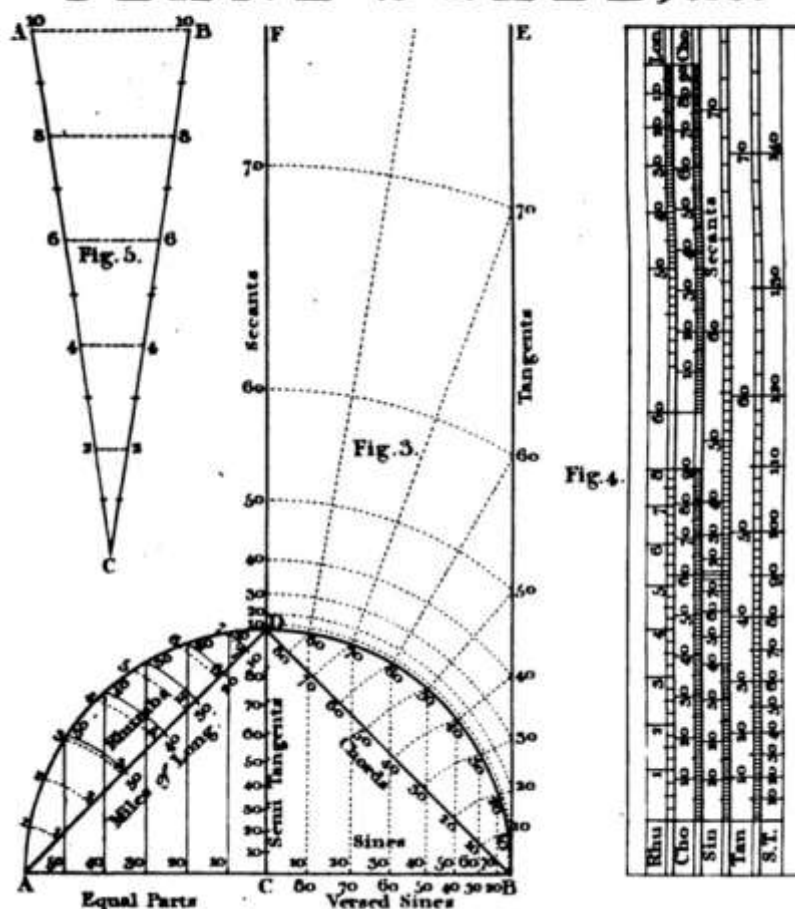


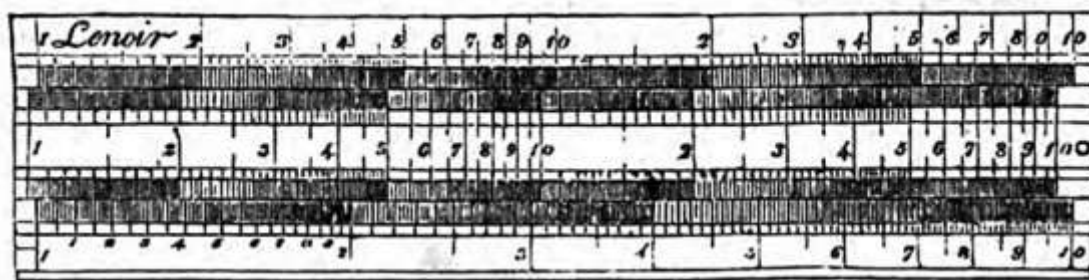
Figure 4. Construction of the Lines on a Plane Scale

The use of these instruments (Gunter scales, pantómetra) is explained in books of mathematics [3] and of navigation [4]. In these books, the construction of the different scales of the Gunter rule was detailed (equal parts, chords, rhumbs, sines...) and how to use the scales, with examples real navigation problems. The same is true of the pantómetra or sector.

The use of these instruments continued until the early nineteenth century, although no Spanish manufacturer for these instruments is known.

The slide rule made by Lenoir appears in dictionaries translated from French. The *Diccionario Tecnológico* (1834) [5] includes the article *Arithmetic (Machines)* explaining that the slide rule, already in use in England, has been brought to France by Jomard. The article further describes how easily all types of operations can be done with this instrument, such as multiplication, division, roots, and "... it even allows to solve triangles ...".

In the *Diccionario de Artes y Manufacturas* (1857) [6], the article *Calculators or Machines to Calculate - Calculators with logarithmic scale - Slide Rule* the Lenoir slide rule and associated operations are described. The author recommends use of the Mr. Lapointe brochure for practical instructions; this booklet was published in Paris in 1846 by the editor Mathias.



poids et mesures		polygones		cercle		ellipse		poids spécifiques	
70 lb = 1451 w	38 Mill = 3911 g	soit A aire	Conte R	quadrilat : circ. = 7	aire : D	Conte 14	Eau. = 1		
11 H = 36 o.	19 m. e. = 5 tel. e.	A ² = N ² C ² R ²	A ² = C ² R ²	aire : diam. = 16					
42 p. v. = 11 p. v.	21 m. e. = 2 P. l. e.	3660	5 50 58 11 5	32 30	aire : circ. = 11	solides	or. = 4	77	fer 11 600 -
3 D = 152	206 m. e. = 3 p. e.	1 : 14	1239 62 11	36 36	polin. diam. = 40 58	pylin. C. R. = 5 48	arg. = 24 5	45	fer 11 600 -
76 M. f. = 39 101.	37 m. e. = 5 tr. u.	482	5 40 51	32 30	aire : circ. = 7 12	sph. C. R. = 20 52	mer. = 61	49	mer 11 600 -
13 D. e. = 4 pied	146 H = 7 P. l. e.	13 5 6	1 1	4 3	7 12 30	pyr. C. R. = 16 48	plom. = 57	1	600 -
27 C. e. = 10 po.	25 lit. = 126 pe	10 11 7	54 34	26 5 14	32 30	cône C. R. = 11 42	étain. = 7	1	600 -

Figure 5. The Lenoir Slide Rule

Neither of these dictionaries mentions the status of slide rules in Spain, probably because these dictionaries were literal translations from French books and the lack of interest of the translator to revise them for Spanish scenarios.

Slide Rules in Spain from 1852 until the Beginning of the 20th Century

Lalanne's Glass Slide Rule

By Royal order on March 8th, 1852 “*Mr Delenill [7], manufacturer of instruments for physics, is allowed for the introduction of a notebook with all the calculations necessary for a better understanding of the new metric rule invented by Mr Lalanne*”, this is a French slide rule.

Real orden permitiendo á Mr. Delenill la introduccion, previo el pago de derechos, de un cuaderno con todos los cálculos necesarios para la mejor inteligencia de la nueva regla métrica, inventada por Mr Lalanne.

S. M. la Reina se ha dignado mandar que se permita á Mr. Delenill, constructor de instrumentos de física y Director de balanzas y pesas de la Casa de moneda de París, la introduccion, previo el pago de derechos, de un cuaderno con todos los cálculos necesarios para la mejor inteligencia de la nueva regla métrica inventada por Mr. Lalanne, y cuyo objeto es el de dar á conocer gráficamente las relaciones entre las antiguas pesas y medidas con el sistema métrico, sin que obste la circunstancia de estar impreso en castellano, por ser parte indispensable para el conocimiento de dicha regla, y no estar por consiguiente comprendida su prohibicion en el espíritu de las establecidas en el Arancel respecto de las impresiones en idioma castellano hechas en el extranjero.

De Real orden lo digo á V. S. para su inteligencia efectos consiguientes. Madrid 8 de Marzo de 1852.—Bravo Murillo.—Señor Director general de Aduanas y Aranceles.

Figure 6. Excerpt of the Royal Order

Summary translation: by this order, Her Majesty the Queen gives permission to have said manual written in Spanish although coming from abroad, on the grounds that it is necessary for understanding and using said new rule (and thus not being included in some sort of prohibition for this kind of documents).

We can verify the existence of this manual, translated into Spanish, in some literature of the time (reference to instructions for the new Leon Lalanne's Glass Slide Rule).

french bibliography 1852

ET DE LA LIBRAIRIE.

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corrigée et suivie d'un appendice contenant des additions importantes. In-12 de 18 feuilles. Imp. de Thunot, à Paris. — A Paris, chez Truchy, boulevard des Italiens, 26. Prix..... 2—50

LIVRES ESPAGNOLS.

4476. CATON CRISTIANO, para uso de las escuelas, que contiene la doctrina y catecismo, ejemplos y maximas dispuestas a formar el corazon de los niños. Nueva edicion, corregida, etc. In-32 d'une feuille. Imp. de Raçon, à Paris.— A Paris, chez Mézin, rue des Poitevins, 2.

4477. GRAMATICA INGLESA, reducida a veinte y dos lecciones. Por D. José de Urcullu. Decima edicion. In-12 de 12 feuilles. Imp. de Gerdès, à Paris.— A Paris, chez Rosa, Bourel.

4478. INSTRUCCION sobre las reglas de calculo y particularmente sobre la nueva regla a cubierta de vidrio, por Leon Lalanne. Traducido por Guillermo de Goyta y Gregorio de Aurre. In-18 de 4 feuilles. Imp. de Crapelet, à Paris. — A Paris, chez Delenil, rue du Pont-de-Lodi, 8.

4479. OBRAS de D. José Zorrilla. Nueva edicion, corregida, y la sola reconocida por el autor, con su biografia, por Ildelfonso de Ovejas. Trois volumes in-8°, ensemble de 98 feuilles 1/4. Imp. de Thunot, à Paris. — A Paris, chez Baudry, quai Malaquais, 3.

Coleccion de los mejores autores espanoles. T. XXXIX, XL, LIV. Obras poeticas. Obras dramaticas. Obras poeticas y dramaticas.

LIVRES ITALIENS.

4480. ALCUNE LIRICHE di Giuseppe Multedo. In-12 de 3 feuilles 1/2. Impr. de Dupont, à Paris.

Figure 6 bis. Excerpt from French Bibliography



Figure 7. Excerpt from the Deleuil Catalog for Lalanne Instructions

Also, the 1863 catalog of the manufacturer, Deleuil, confirms this authorization, (the picture shows the line 611 with the León Lalanne rule in Spanish and below a comment stating the mentioned permission). Note that the previous and the following articles refer to the owner as Deleuil, with "u", although the Spanish Royal order refers to Delenill with "n". Given the circumstances, we understand this spelling difference to be a typing or transcription error.

CADASTRE ET MARINE.		59
Règles et Machines à calculer.		
609	Règle à calcul, française, en bois, avec instruction.. . . .	7 "
610	— sans l'instruction.. . . .	6 "
611	— espagnole, avec l'instruction théorique et pratique de Léon Lalanne, ingénieur des ponts et chaussées.	6 "
612	Règle allemande, par le même.	6 "
Nous sommes seuls possesseurs de ces deux règles, et nous sommes autorisés, par un décret de S. M. la reine d'Espagne, d'introduire, au même titre que les ouvrages publiés dans ses États, la règle à calculer avec l'instruction théorique et pratique.		
613	Arithmomètre de Thomas de Colmar, avec instruction pour un produit de 10 chiffres sans quotient.	175 "
614	Arithmomètre pour un produit de 12 chiffres avec quotient.	340 "
615	— — — 16 —	340 "
616	— — — 16 —	450 "
617	— — — 20 —	900 "

Figure 8. Excerpt from the Deleuil Catalog for Authorization

In addition to the instructions written by the same Lalanne, this rule is explained in detail in several books:

In *Lecciones de Aritmética* [8] by P.L. Cirodde, book translated from French, states that "... one of the most ingenious practical applications of logarithms is the use of the Slide Rules or logarithmic Rules ... we will assume that there is a slide rule at hand, and most especially the glass slide rule from M. Leon Lalanne..."

The book details the theory and operation of the rule and describes all possible operations.

In *Lecciones de Algebra* [9] by the same author P.L. Cirodde, the operation of the rule is described almost copying the Lalanne's written instruction, including reproducing a chart prepared by Lalanne for all operations that can be performed with the slide rule. The ending chapter on the slide rule concludes:

467. Las aplicaciones de la Regla de cálculo á las cuestiones usuales de geometría, mecánica, química, etc., son en extremo numerosas. Sería demasiado prolijo enumerarlas aquí, por lo que recomendamos eficazmente á nuestros lectores que, consulten la *Instrucción acerca de las reglas de cálculo* de M. L. Lalanne. En esta obra hallarán, con todos los desarrollos necesarios, una colección numerosa de cuestiones, cuya resolución acabará de familiarizarles con el uso de la regla de cálculo, y les hará comprender toda la utilidad práctica de tan ingenioso instrumento.

Figure 9. Excerpt from *Lecciones de Algebra*

Summary translation: Refer to the Lalanne manual for more details and examples of the use of this ingenious instrument. The Lalanne slide rule is briefly described in Appendix I.

The Gravet Lenoir slide rule

In the *Aritmética generalizada* ... by Ramon Fernandez y Parreño (1861) [10] in the article *Logarithmic Machines*, the author cites two rules "... among the most notable is the logarithmic rule or calculator with glass pannels from Leon M. Lalanne; the one from F.A.Artur..."

The purpose is to make the public aware of the Artur rule [11] whose original model "... can be seen in this enterprise (?) so that those who want to practice the application of these machines to numerical operations can order the manufacture of other equal instruments..."

The article continues with the *Instruction on the logarithmic rule or calculator from J.F. Artur*, which is another French rule. The Gravet Lenoir slide rule is described and depicted in the book (see Appendix II); the most common operations are explained with many examples.

D. Juan Pons y Monjo publishes a book in 1862 [12] on the Gravet Lenoir rule, ten years after the Royal Order authorizing the import of the Lalanne rule.

In the introduction to this 1862 book we learn that the author was inspired by the instructions for this slide rule written by the French engineer Guy [13] "... adapting the data to the use of the Spaniards, giving some preference to the Catalan provinces over the rest, given the greater use that will be made of this method by their natives, attending the remarkable development that the industry has reached there..."

The instructions explain the advantages of using this slide rule and the universal use from the director to the operator, "... waiting for the government to introduce it in the specialized courses in the kingdom ...".

The book's introduction ends with the following strange paragraph, in which one deduces that either the author is not aware of the existence in Spain of the Lalanne rule or he did not know of any other manual for the Gravet rule, despite the existence of Arithmetic book by Parreño, 1861, already cited above:

No teniendo conocimiento de que exista entre nosotros ninguna publicación, original ni traducida, que llene el objeto que me he propuesto en este opúsculo, me he decidido á publicarlo, con el fin, que siempre me ha guiado, de ser útil á mis compatriotas.—Si lo consigo, quedaré satisfecho.
(Brief translation: the purpose is to publish a new manual to be helpful to his countrymen).

The book explains in detail the use of the slide rule with many practical examples. At the end of the book, there is a statement that this rule was for sale in the library of Salvador Manero, in the Rambla of Santa Monica, and in the facilities of D. Nicholas Planella and D. José Rosell, mathematical instrument makers [14].

Review Appendix II for more details on the Gravet rule.

Logarithm Tables

There are books from the same era that do NOT mention the slide rule at all and explain the resolution of all problems by using the tables of logarithms. The best known is the work *Tablas de Logaritmos* by Vazquez Queipo [15]. The author presents the benefits from using logarithms and uses over 91 pages to present the theory and practice of logarithms. There are many examples for practical applications, along with the tables, including those for trigonometric functions. No mention is made of slide rules.

In *Las Matemáticas para los niños...* by Acisclo F. Vallin y Bustillo (1861) [16], the author explains the importance of the knowledge of logarithms.

En la segunda parte tal vez parezca extraño que tratemos, siquiera muy sucintamente, de las abreviaciones y facilidad en los cálculos, que ofrece el conocimiento de los logaritmos; pero es tal en nuestro concepto la utilidad, que ha de resultar de la generalización de este poderoso instrumento aritmético, que no hemos vacilado un momento en añadir con este objeto un capítulo mas á nuestro libro, contando con la baratura y sencillez de las tablas de logaritmos de los números naturales, publicadas recientemente con tan buen éxito por nuestro ilustrado amigo el Excmo. Sr. D. Vicente Vazquez Queipo, individuo de la Academia de Ciencias y del Real Consejo de Instrucción pública.

Figure 10. Excerpt from *Las Matemáticas Para los Niños*

The author expounds on the properties of logarithms and provides some operational examples, advising the student to refer to the Tables by Vazquez Queipo due to the large number of included solved problems.

In 1864 Don Evaristo Antonio Mosquera published a book [17] mentioning the Lalanne slide rule and others. He blames these instruments for a lack of accuracy and offers his tables or abacuses as an improvement. The book is a manual for using the abacus that contains: the abacus for products and quotients, the abacus for squares, and the abacus for cubes. These abacuses are 'Ready Reckoners', where the result of the multiplications, divisions, etc ... can be found in two-entry tables.

Other Slide Rules of the Same Period

The book by Mr. Ramon Fernandez y Parreño [10] presents other calculators as well as the rule of Artur; these are two American calculators invented by Fuller (reproduced in Appendix III) and the French calculator by Perret.

- The Telegraphic Calculator from Fuller (Fuller's Time Telegraph) "... wonderful and unique instrument with whose help all the arithmetic problems of any kind are resolved in an instant..."
- The Palmer's Computing Scale from Fuller.
- The Calculating Disc from M. Adrien Perret, patented in Paris on November 22nd, 1858, has 8 scales: numbers, squares, cubes, logarithms...; the calculations are carried out by two independent cursors that revolve around the axis or centre of the disc.

The operation of Fuller calculators is illustrated with many examples. We do not know whether these three calculators were sold in Spain.

Slide Rules in Spain in the late 19th and early 20th Centuries

The influence of the French rules is diminished as rules made in other countries appear, including Spain.

Since this period is not the main topic of this work; we will only make a chronological list of some of the rules that appeared in Spain in the late 19th century:

1881- Description of a tachimetric rule without giving the manufacturer name [18] (Appendix IV). This French rule, the Moinot rule was made by Tavernier Gravet in 1877.

1883- The Valencia Regional Exhibition Catalogue [19] mentions a "Case of slide rules" signed by the widow of Rosell. We have already discussed the mathematical instrument maker Jose Rosell [14].

1886- Description of a rule for calculations for concrete invented by an engineer from India and manufactured by Stanley: the Ganga Ram's Calculating Scales [20]
(Appendix V)

1896- In a treatise on arithmetic that was part of the official program of the Central School of Arts and Crafts, Lesson XI, [21] there is a reference to the slide rule: "... *this instrument, ingenious and practical application of the theory logarithms, and that can be acquired at a small price, is useful despite the inaccuracy of the results...*".

The treatise does not give many explanations, but recommends consulting the monographic by Maurice Leclair that explains the Tavernier Gravet rule.

The first French edition of this monographic [22] is from 1894. The author says he wants to popularize the book by GUY [13], which is too complex for the uninitiated. The book presents the 'ordinary' rule (i.e., the Lenoir one, with SOHO scales), and the Mannheim rule (Rietz type). We do not know if there was a Spanish edition of Leclair's book.

1897- Description of several rules in a manual by Auguste Muller and Louis de Peña [23]:

The introduction stated:

"... *The book is considered as the best in this issue; it has been adopted by the Swiss and German schools, and we believe that it will contribute to promote the use of the Slide Rule in Spain, not yet commonly adopted by many due to the ignorance of its operation...* "

The operation of two rules is explained; the simple rule (SOHO scales) and the double rule (Mannheim), without specifying any manufacturers.

The last part of the book is about the rule with two slides, e.g., the Peraux rule made by Tavernier-Gravet (Appendix VI).

The major European manufacturers (Dennert & Pape, Nestler, and A.W. Faber) start selling slide rules in Spain a few years before 1900.

The tachymeter rule from Alcayde [24] was patented in 1915 and compulsory in Military Academies and for the exams to enter in these schools [25]. Some examples of this rule exist today (Appendix VII).

Conclusion

The Royal Order of 1852 is clear evidence that the first rules introduced in Spain, at least officially, were the French Lalanne 'glass rules'. Before that date we have no evidence of the presence of any other modern slide rules.

A few years later we find the presence of Gravet Lenoir rules, also French. Judging from the evidence found in the books of that time, these had lower sales than the Lalanne rules, which were cheaper.

References

1. Zaragoza, Joseph, *Fábrica y uso de varios instrumentos matemáticos con que sirvió al rey Ns D. Carlos Segundo*, Madrid, 1675.
2. Navarro-Loidi, Juan, *La incorporación de los logaritmos a las matemáticas españolas*.
<http://divulgamat.ehu.es/weborriak/Exposiciones/ExpoHistoria/Logaritmos/inicio.asp>
3. Borclazar de Artazu, Antonio, *Proporción de monedas, pesos i medidas con principios prácticos de Arithméticas i Geometría para su uso*, Valencia, 1736, page 72.
4. Tosca, doctor Thomas Vicente, *Compendio de matemáticas*, Volume 1, Valencia, 1757, page 359.
5. Fernández de Medrano, Sebastián, *El arquitecto perfecto en el arte militar*, 1700.
6. Bails, D. Benito, *Principios de Matemática de la Real Academia de San Fernando*, Volume 1, 2nd edition, Madrid, 1788.
7. Macarte y Diaz, Dionisio, *Lecciones de Navegación o Principios necesarios a la ciencia del piloto*, 1819.

8. Written in French and translated into Spanish by D.F.S. y C.', *Diccionario Tecnológico ó nuevo Diccionario Universal de Artes y Oficios*, Volume IV, Barcelona, 1834, page 23.
9. SPANISH EDITION published by D. Francisco de P. Mellado following the second French edition by M.C. Laboulaye, *Diccionario de Artes y Manufacturas de Agricultura, de Minas,..etc.* second volume, Madrid/Paris, 1857, page 273. The first French edition of this dictionary is of 1845.
10. A printing error may be observed, as the right name is Deleuil instead of Delenill.
11. Cirotte, P.L. (mathematics teacher in Liceo Napoleón of Paris), (translated from French by D. Francisco Zoleo), *Lecciones de Aritmética*, Madrid, 1857.
12. Cirotte, P.L. (mathematics teacher in Liceo Napoleón of Paris), (translated from French by D. Bartolomé Peregrin), *Lecciones de Algebra*, Madrid, 1863.
13. Fernandez y Parreño, Ramón, *Aritmética generalizada y recapitulación de las operaciones necesarias a los comerciantes, labradores y artesanos*, Second Volume, Sevilla, 1861, page 298.
14. Artur, J.F.. *Instruction théorique et applications de la règle logarithmique, où à calculs*, 4th edition, Gravet, Paris, 1845.
15. Monjo y Pons, D. Juan, *Cálculo Instrumental explicado sobre la regla calculatoria de GRAVET LENOIR* 'Método útil y accesible a todas las clases industriales desde el director de un taller o empresa hasta el último operario', Barcelona, 1862.
16. Guy, Chez Gravet (successeur de Lenoir), *Instruction sur la Règle à Calcul*, 3rd edition, Paris, 1855.
17. D. Nicolás Planella y Don José Rosell: these manufacturers appear in the Barcelona Commercial Guides (1849, 1863), that contain the list of shops in this city.



Figure 11. Cover page of Plannella catalog

(Brief translation: refers to "speciality in ... articles for architects, engineers,..., and draftsmen).

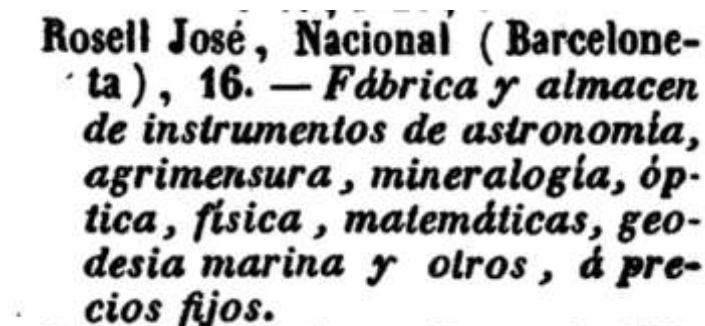


Figure 12. Cover page of Rosell catalog

(Brief translation: Manufacture and store of instruments for astronomy, surveying, mineralogy, optics, physics, mathematics, marine geodesy and other, at fixed prices).

18. Queipo, Dr Don Vicente Vazquez, Tablas de logaritmos vulgares con seis decimales, 4th edition, Madrid, 1857, [translation: *Work declared as text for upper primary education schools and students of philosophy at colleges and universities*]. These famous tables were updated until 1974 (45th edition).
19. Vallin y Bustillo, Don Acisclo F., Aritmética para los niños que concurren a las escuelas de primera enseñanza, 6th edition, Madrid, 1861.
20. Mosquera, Don Evaristo Antonio, Ábaco Aritmético o nuevo sistema de cálculo numérico en gran parte mecánico, Pontevedra, 1864.
21. Peironcely, Ramon, *Regla logarítmica*, Revista de Obras Públicas, Volume XXIX, nº16, 1881.
22. Castel, Josep Simon, *Colección de instrumentos científicos del IES Luis Vives*, University of Valencia, 2003.
23. *La regla Ganga Ram*, Revista de Obras Públicas, volume IV, 1886, and the Journal of the Oughtred Society, 3:1, 2007.
24. Mezquita y Fernandez, Don Roman, *Tratado elemental de aritmética práctica*, Madrid, 1896.
25. Leclair, Maurice, *Méthode simplifiée et applications pratiques de la REGLE A CALCUL*, 19th edition, Paris, 1907.
26. Muller-Berthosa, Don J. Agosto, (translated directly from German and extended with *La Regla de cálculo de dos reglillas*, Don Luis de la Peña y Braña), *La regla de cálculo explicada con multitud de ejemplos*, Madrid, 1897.
27. Alcayde y Carvajal, Nicomedes, *Regla de cálculo de bolsillo*, 1916. Patent no ES61371 filed on December 13th, 1915, as requested by the Asociación de Santa Barbara y San Fernando.
28. de Rosas, Ricardo F., *Regla de cálculo: aclaraciones para el uso de la del sistema alcayde en las aplicaciones que han de exigirse en los exámenes de ingreso en las Academias Militares*, 1916.

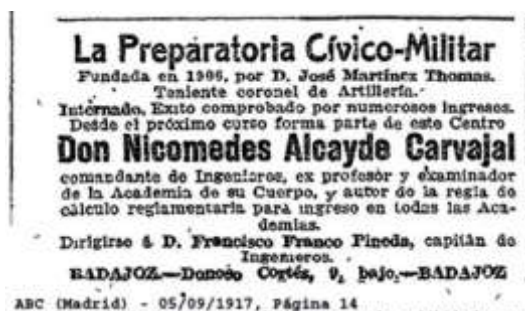


Figure 13. Advertisement for a military academy with Mr. Alcayde as the teacher and author of the official slide rule for these academies

APPENDIX I. The Lalanne Glass Slide Rule

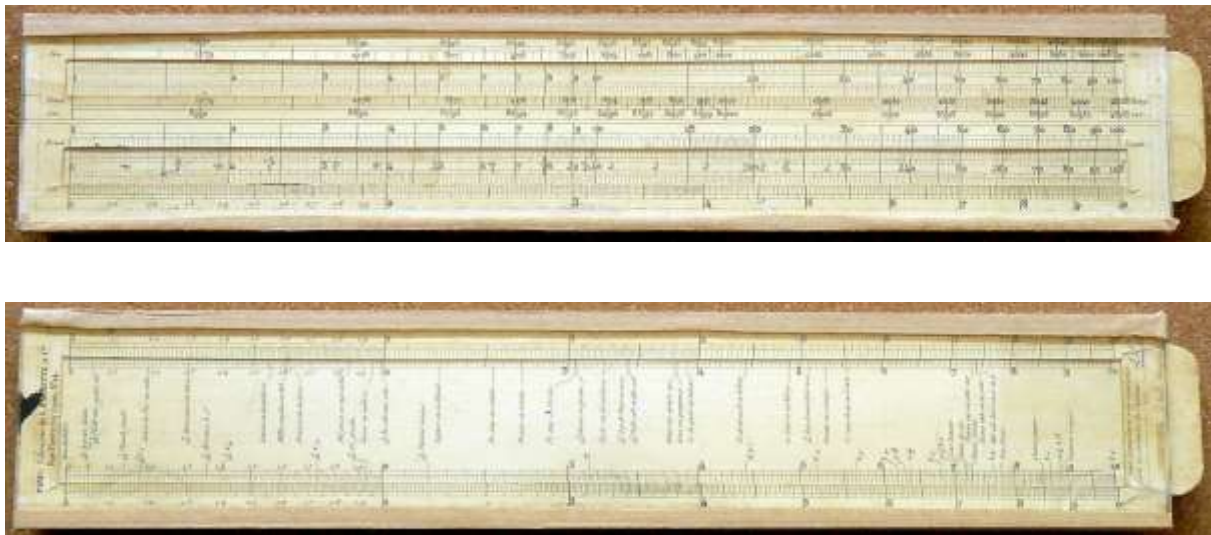
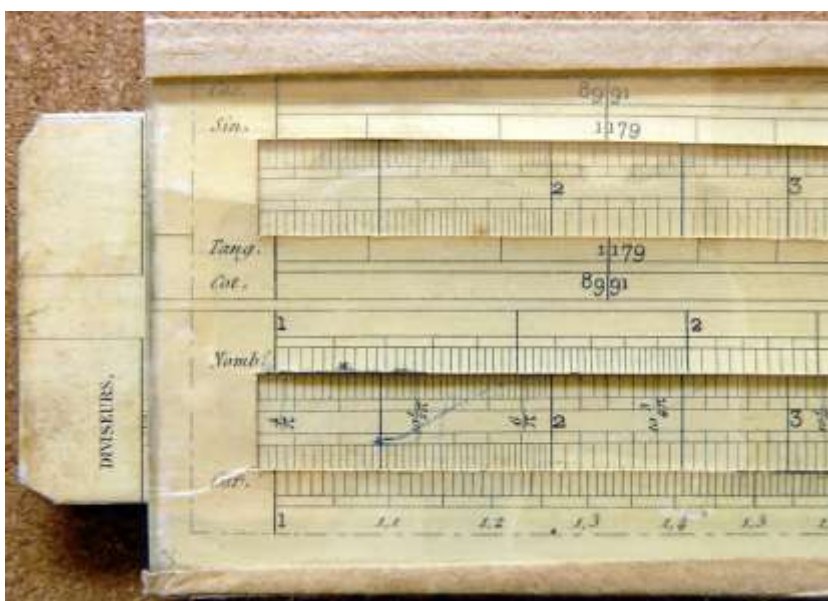


Figure 14. The Lalanne Glass Slide Rule (top and back views)



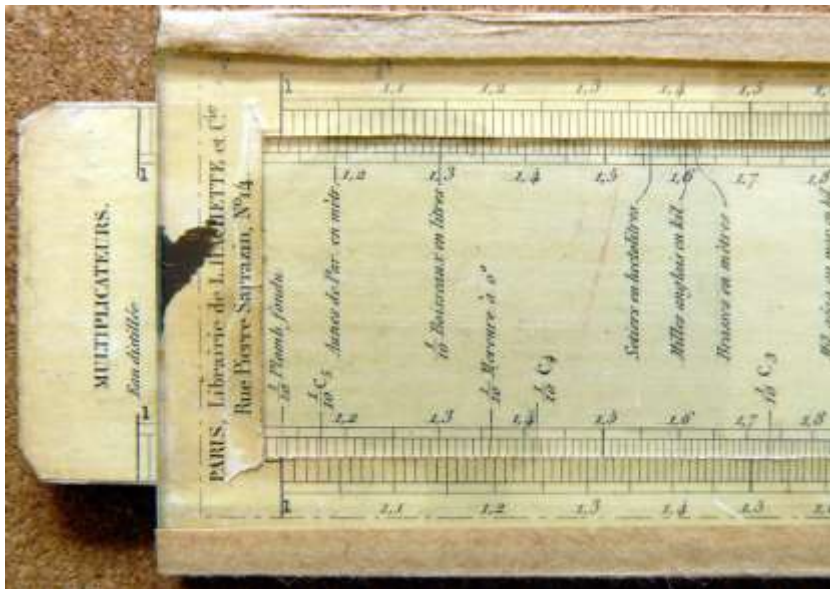


Figure 14 bis 1 and 2. The Lalanne Glass Slide Rule (detail views)

GMA collection http://www.photocalcul.com/Calcul/Regles/Autres/photo_lalanne.html



Figure 15. The Lalanne Glass Slide Rule (end view)

This rule is composed of a slide which slides inside a sleeve, both of cardboard with printed scales, and two glass plates covering the slide-frame.

With regard to the circumstances that lead to adopting this structure, Lalanne tells us in this way:

"... the slide rule had just been introduced in secondary school and was on the list for admission to the Polytechnic School and the Military School; the only constructor Lenoir had not yet finished his assembly platform; it was then that Lalanne imagined a rule cheap and fast of manufacturing; in a few weeks he was able to deliver hundreds of his rule in public schools...", (*Leçons de statique Graphique* – 2nd edition - *Calcul Graphique*, Antonio Favaro, Paris 1885, page 94).

On one side of the rule there are, separated, the trigonometric scales and the 'classic' ones, of the type SOHO ($A = B = C$, D); the other side of the rule has a number of conversion factors over the slide (inches into cm, 'Setiers' into hectolitres...); the rule is constructed in such a way that other constants are easy to add over the slide.

The royal order stated that "... the purpose of the Lalanne rule is to graphically raise awareness of the relationship between the old weights and measures with the metric system..."

This suggests that the conversion factors were adapted to the old Spanish measures. Not knowing any specimens, or manuals, sold in Spain, we have not been able to verify this.

Obviously a glass slide rule is a fragile object, of which few specimens are preserved today. (More details are in the *Journal of the Oughtred Society*, 7:2, 1998).

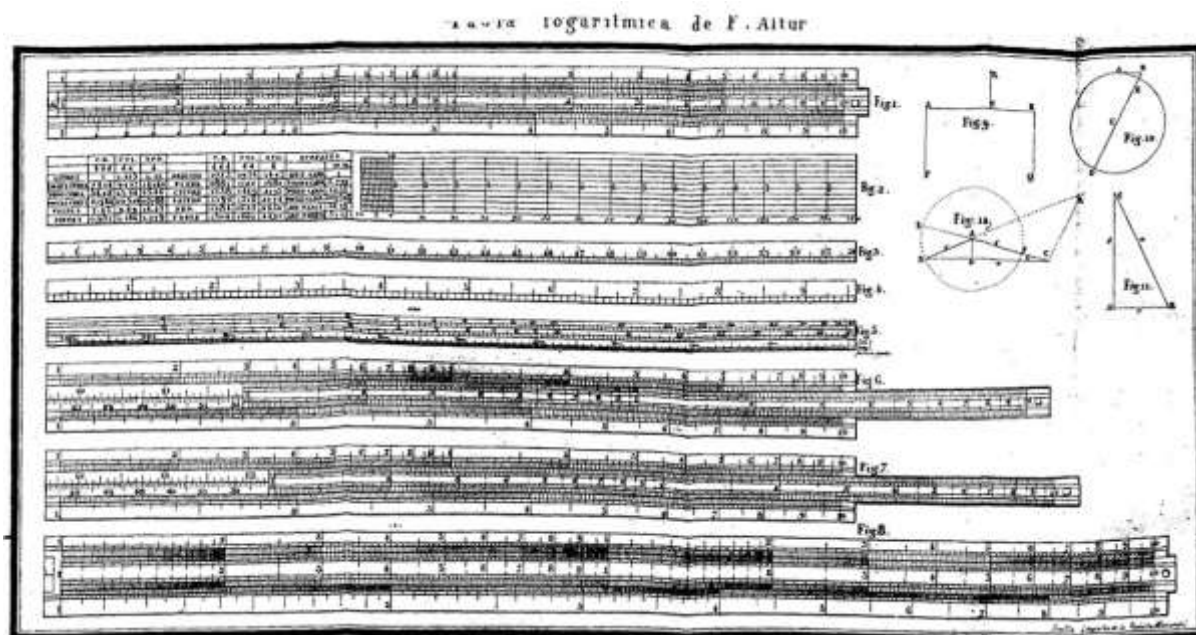


Figure 16 bis. The regla *logarítmica* de F. Artur
Aritmética generalizada, Ramón Fernandez y Parreño, 1861.

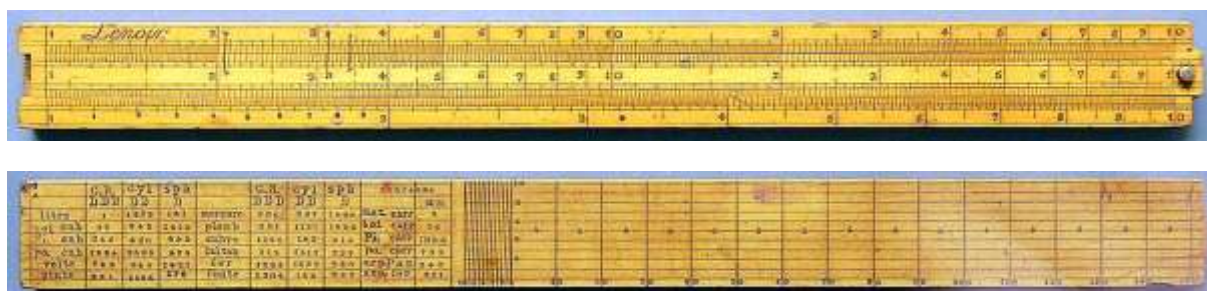


Figure 16. The Gravet-Lenoir Rule (top and back views)

http://www.photocalcul.com/Calcul/Regles/Collection_Etienne_Sigismond/reglesEtienne1.html
 E.Pommel collection

The rule represented in the drawing is the classic 'Lenoir', which Gravet, his successor, continued to manufacture. The scales are of the SOHO type ($A = B = C, D$), and so the cursor is not necessary; the trigonometric scales are on the back of the slide.

This rule was gradually replaced by the Mannheim rule (1851) that has different distribution of scales and has a cursor.

Aritmética generalizada, Ramón Fernandez y Parreño, 1861

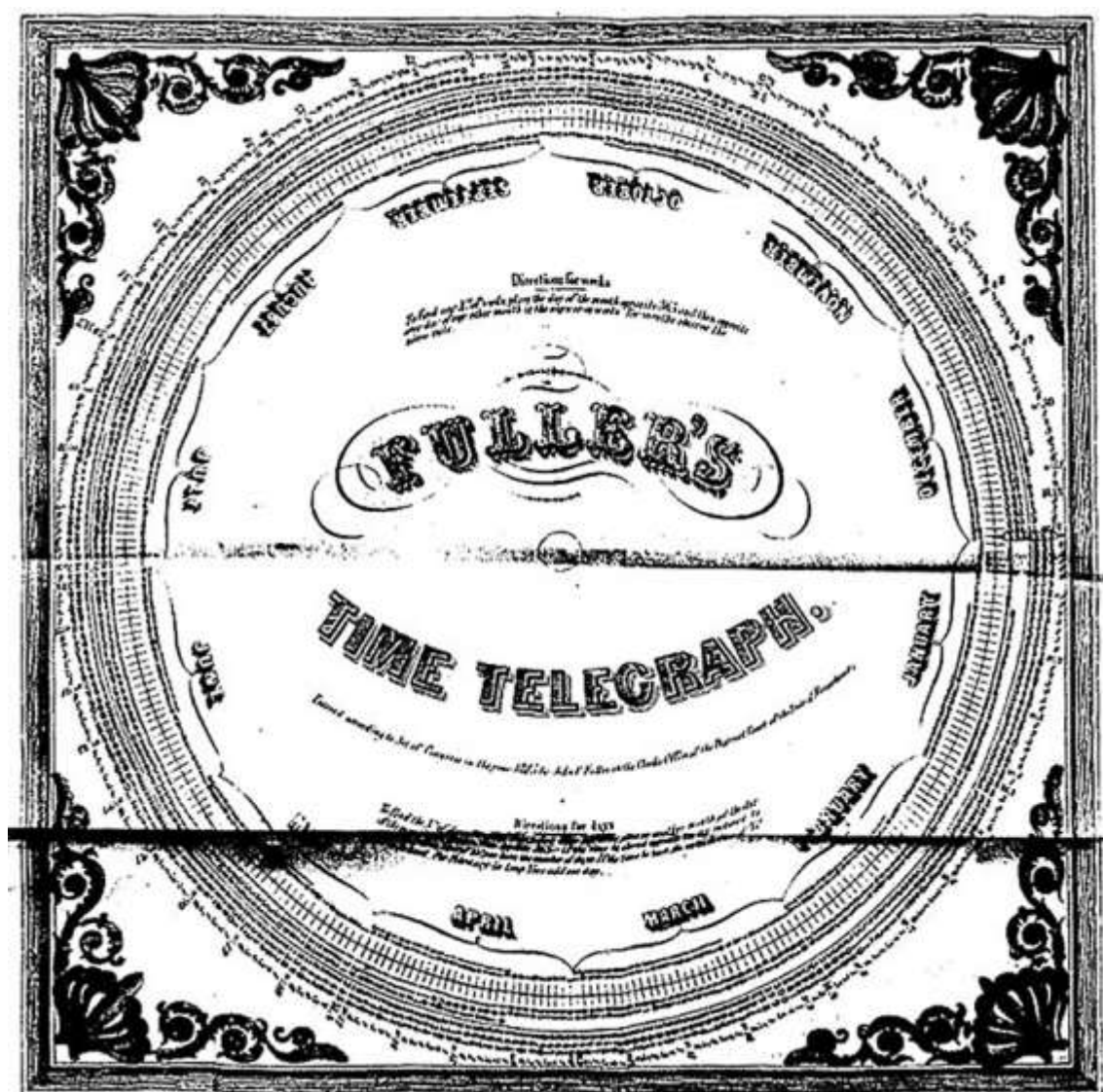


Figure 17. Fuller Time Telegraph Calculator



Figure 18. Palmer's Fuller Computing Scale

APPENDIX IV. The Tachimetric Rule

Regla logarítmica, Ramon Peironcely, Revista de Obras Públicas, 1881

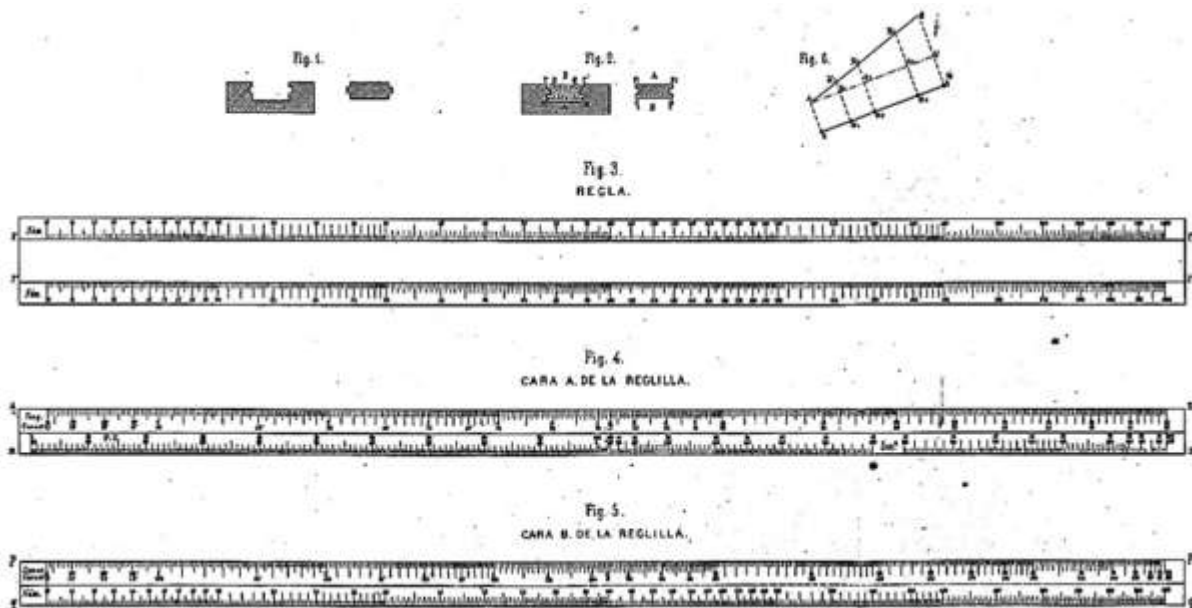


Figure 19.1 The Tachimetric Rule

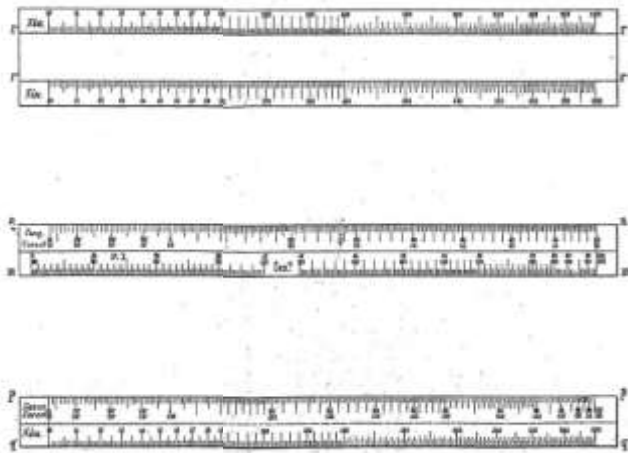


Figure 19.2 The Tachimetric Rule

La regla Ganga Ram, Revista de Obras Públicas, 1886

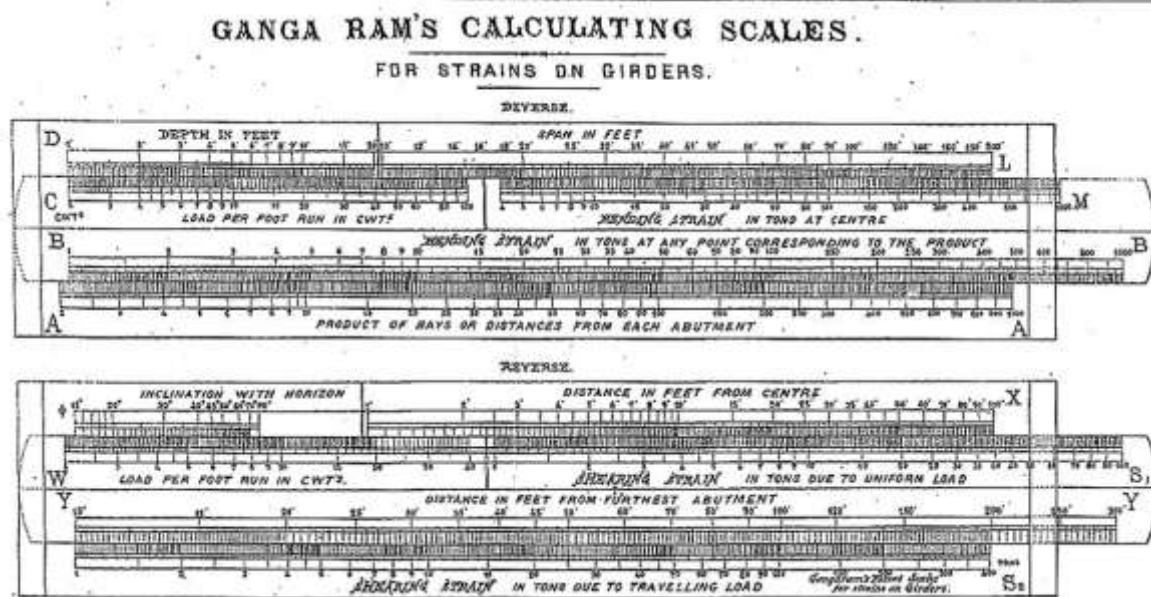


Figure 20. Ganga Ram's Calculating Scales

APPENDIX VI. The Peraux rule, with two slides (Tavernier Gravet)

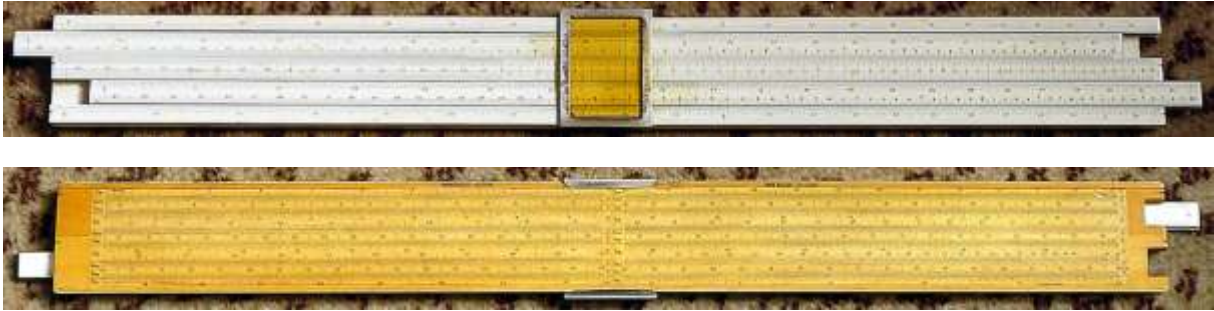


Figure 21. The Peraux Rule (top and back views)

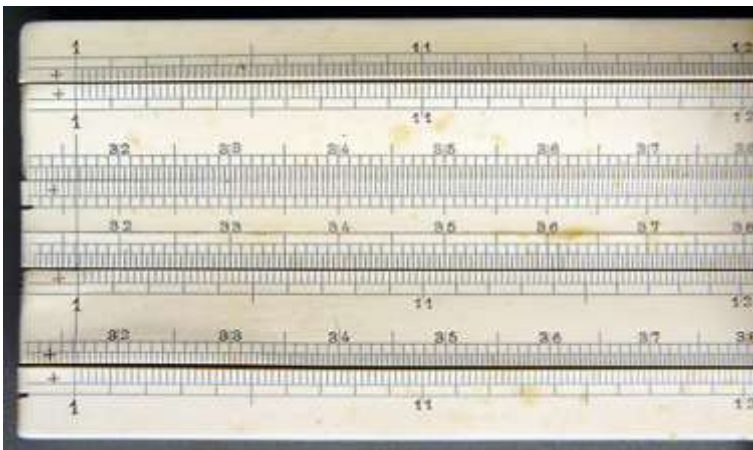


Figure 22.1 The Peraux Rule (detail views)

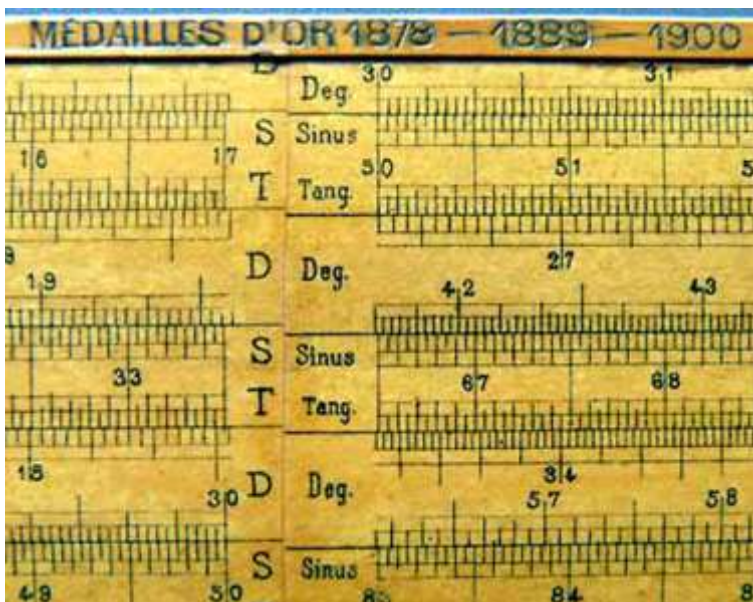


Figure 22.2 The Peraux Rule (detail views)

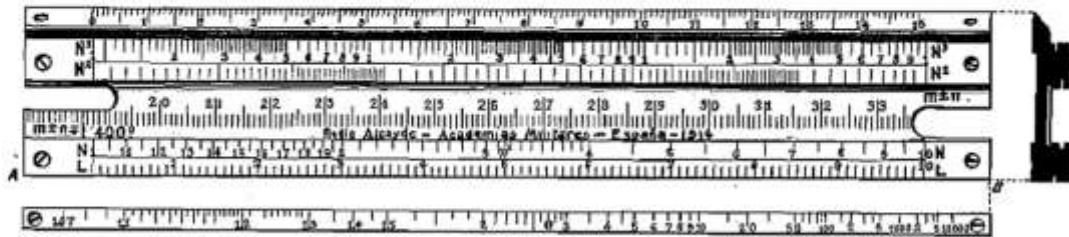
E. Pommel Collection

REGLA DE CALCULO MODELO ACADEMIAS MILITARES



Regla

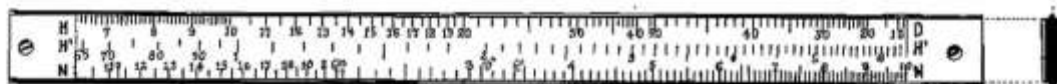
Fig. 1^a



Escala de potencias del borde A.B. de la regla

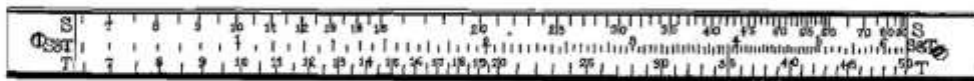
ANVERSO DE LA REGLILLA

Fig. 2^a



REVERSO DE LA REGLILLA.

Fig. 3^a



Escala natural

Nicomides Alcyde

Figure 23. The Alcyde Rule (illustration)



Figure 24. The Alcyde Rule (slide removed)

GMA collection http://www.photocalcul.com/Calcul/Regles/Autres/photo_xxxArtilleria.html