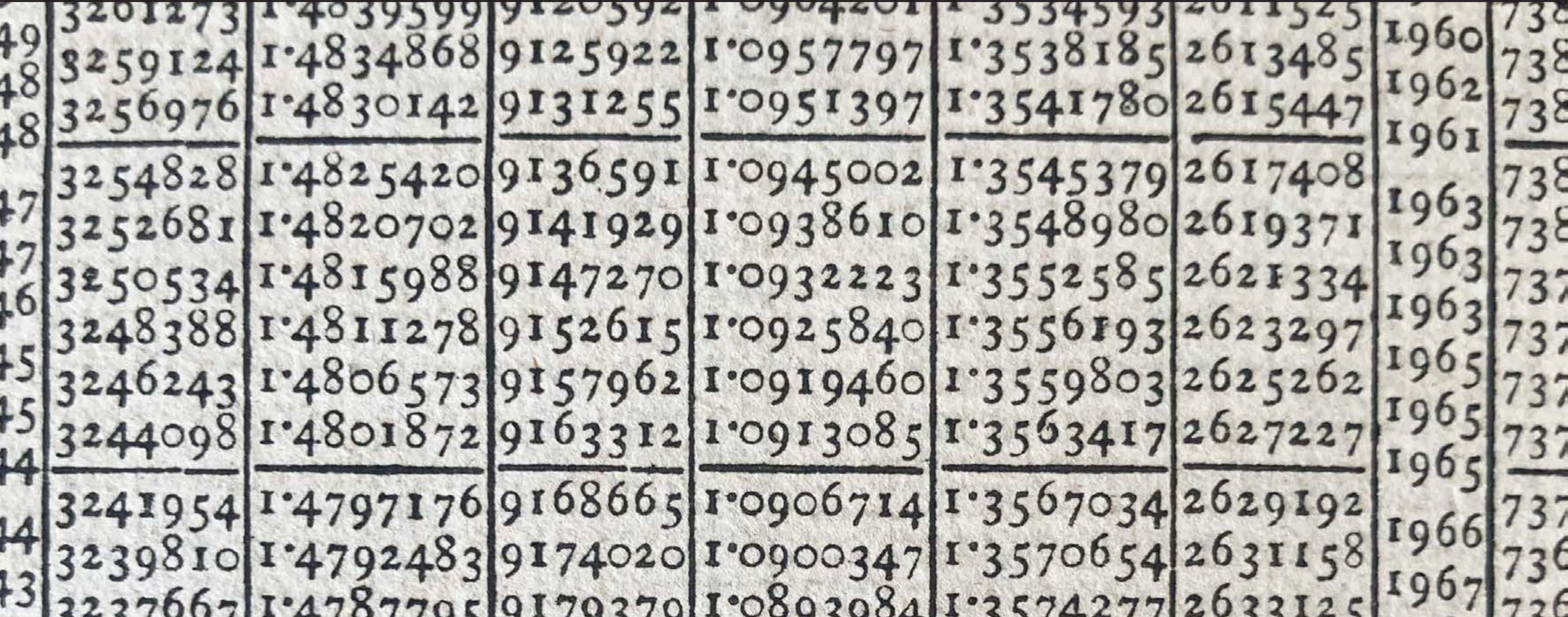
A HISTORY OF COMPUTING

PART I: ORIGINS, 1630–1946



BORIS JARDINE | RARE BOOKS

BJRB

CATALOGUE	#3, MAY 2024, PDF
COVER ITEM	#8, WHEN COMPUTERS WERE HUMAN
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NO. 1 THE RENAISSANCE COMPUTER: A MATHEMATICAL SECTOR BY ELIAS ALLEN

Brass Calculating Sector by Elias Allen
Signed 'Elias Allen fecit', London, England, *c.*1630

455mm (fully extended)

Very good condition: surface marked and pitted but all engraving legible and hinge working smoothly; housed in a custom-made clamshell box

[SOLD]

A FINE AND VERY EARLY CALCULATING SECTOR by London's leading craftsman, made *c.*1630 to the design of Edmund Gunter. The essence of the sector is the method of similar triangles: the 'legs' of the hinged sector carry identical scales, and with a pair of dividers in hand calculations can be made by applying known numbers to find unknown numbers. The principle was co-discovered by Thomas Hood and Galileo around the year 1597. Historian of science Stillman Drake writes that the sector was 'the first mechanical computing device', predating by half a century the more famous machine invented by Blaise Pascal.

Edmund Gunter's 1623 description of the sector marked a leap forward in the design of the instrument, extending its use into many new areas of application. The present version is identical to the standard 1623 design, except that it has one additional scale, the purpose of which remains unknown. Elias Allen was London's leading craftsman: he was trained by the Elizabethan maker Charles Whitwell, and was a collaborator of Gunter, William Oughtred and other mathematicians.

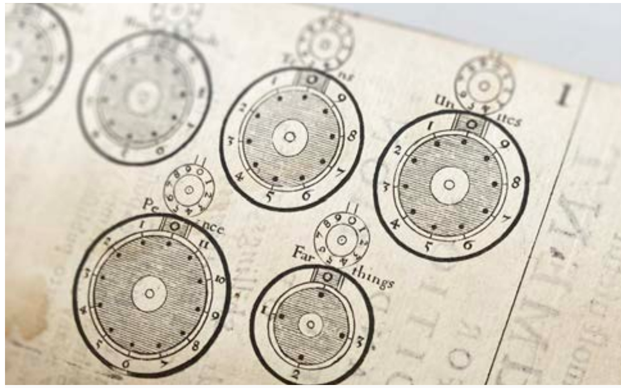
NO. 2 THE FIRST BOOK ON CALCULATING MACHINES

MORLAND, Samuel, *The Description and Use of Two Arithmetick Instruments* (Moses Pitt, London), 1673

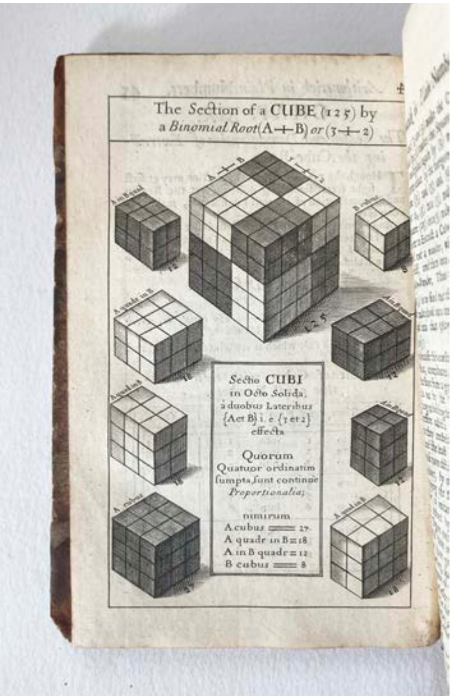
Small 8vo; various paginations, 25 plates
Collation: $\mathcal{A}^8$ B–F^8 A^8(–A8) G^8(–G8) B^8 $*^8$

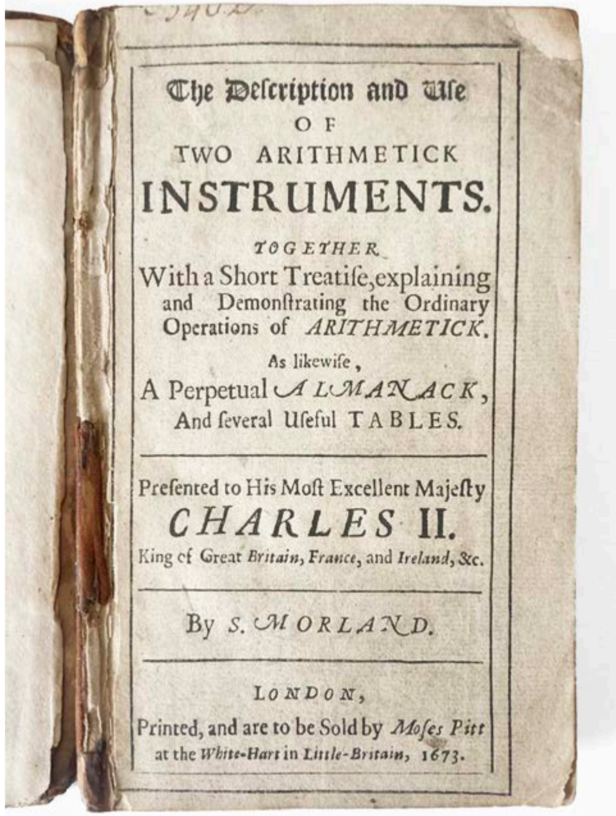
Fair condition: text and plates in very good condition, noting some faint staining to the lower half of the first 7 or so leaves; disbound, retaining early boards, spine separated and therefore due a sensitive rebind

£11,500



A LANDMARK TEXT by the courtier and inventor Samuel Morland (1625–1695). Preceded in the bibliography on modern computing only by works on the sector (see no. 1), Napier's Bones (see no. 6), and Pascal's manual for the 'Pascaline'. Here Morland introduces his machines for addition and subtraction (of currency), and for arithmetic. The book is also a compendium on calculation, including a perpetual almanac, tables of feasts and eclipses, and much else besides.





Two Arithmetick Instruments is a highly unusual production. The engravings are very fine, and some pages are printed in letterpress on one site and copperplate on the other. But it is a bibliographic conundrum, with many pagination errors and no standard collation. This copy is unusual in having all the plates fully intact, and lacks only the portrait frontispiece.

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NO. 3 THE CLASSIC JAPANESE TEXT ON THE ABACUS

ISOMURA Yoshinori, *Zōho Sanpō ketsugishō* (Nagamura Hanbē, Keishi [Kyoto]), 1684

160 x 227mm; pp. 46 leaves, woodblock printed, Fukuro-toji style

Fair condition: limp binding badly deteriorated; internally surprisingly good, mainly owing to the durability of the paper; edges folded and creased by text legible and clean

[SOLD]

An important edo period volume, with an advanced account of the abacus. This first volume (of five) of Isomura's *magnum opus* concerns arithmetic, and contains many illustrations of problems that can be solved by the abacus. The first edition was published in 1661; this revised edition was the last published in Isomura's lifetime. The work was also reissued much later, in 1804.

The abacus is an ancient calculating device, with evidence of its use dating back two or three millenia BC. Isomura brought the use of the instrument to a new level of perfection, and for this reason was known as 'the master of the abacus'.

Worldcat locates only three copies of this edition (Library of Congress, Columbia University, and Linda Hall Library). Another copy is located at the Swedish Royal Collection.

1686

NO. 4 ONE OF THE EARLIEST SURVIVING SLIDE RULES

A Very Early Boxwood Slide Rule by Isaac Carver
Signed and dated 'Is Carver Fecit 1686', London, England

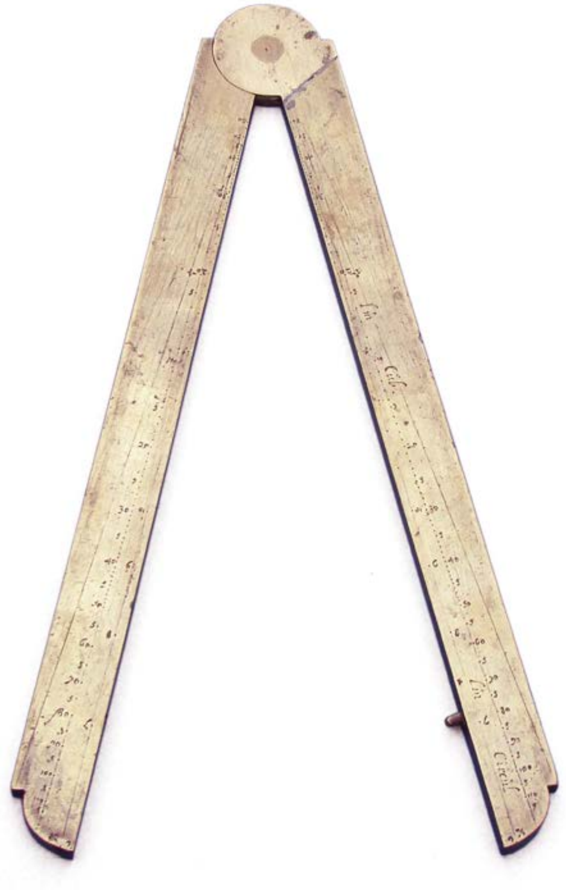
316 x 20 x 16mm

Very good condition: minor wear to the corners and some surface marks

[PRICE ON REQUEST]

An exceptional survival, predated by only three extant rules (the Bissaker slide rule at the Science Museum, dated 1654, and two other Carver rules dated 1683 and 1684). It has scales on all four sides: inch, foot, square roots, cubes, spheroid, parabola, conoid, numbers, secants.

Judged solely by its impact, the slide rule is surely the most significant calculating device before the computer. It was invented in the 1620s by William Oughtred, and consists of two logarithmic scales sliding against one another. Immediately applications were found in all areas of calculation, notably navigation, as well as in the new area of customs and excise. Early examples are scarce, as are any early wooden instruments (see also No. 5).



NO. 5 MUSICAL CALCULATIONS IN 17TH-CENTURY GERMANY

A Calculating Sector with Musical Scale
Brass, German Lands, *c*.1690

190mm (closed) to 360mm (open)

Good condition: general surface wear but all scales fully legible

£6,500

A MUSICAL SECTOR, probably German, late 17th century. This unusual sector has standard scales for computing distances, areas, etc. But it also has a musical scale of 12 notes, spaced nonlinearly and representing the differences in pitch:

fi, G, G-is, a, b, h, C, C-is, D, D-is, E, f

This is the German nomenclature, distinguished by the '-is' abbreviation sign for 'sharp', the 'b' for B-flat, and the zigzag-h for B-natural (see Apel, *The Notation of Polyphonic Music, 900–1600* [1942]). Such a musical scale can have many uses in the design and construction of musical instruments, for example calculation of lengths of lute strings or organ pipes, of string gauges or tensions, or even of bell diameters.

The only other musical sector scales we have found are on very large German instruments (see de Pecker, 'An unusual early sector explored' [2007]), and the fine example at Oxford, inv. no. 45547). (See also No. 18 in this catalogue for a later musical slide rule.)

NO. 6 NAPIER'S BONES: THE BEGINNING OF THE CALCULATING MACHINE REVOLUTION

A Fine Set of Napier's Bones in Boxwood
English, *c*.1700

104 x 65 x 17mm (case when closed)

Very good condition: surface wear and markings consistent with age; complete and unusually well preserved

[SOLD]

THE FIRST MODERN DIGITAL CALCULATING INSTRUMENT. An original set of napier's calculating rods, English, late 17th century, in boxwood, contained in the original case with 'Cambridge Panel' binding style decoration. The box contains 16 four-sided calculating rods and the tabulat carrier. The numeral punches all match, and the set is complete. This set was made with a full 16 rods (for multiplying very large numbers), instead of supplying a square/cube rod. Inscribed in ink in the tabulat is a tally of the number of sides available (either 6 or 7) for each digit from 0 to 9, for the total of 64 sides.

In 1617 John Napier (1550–1617), of Merchiston, Scotland, published *Rabdologiae*, in which he revealed his newly invented calculating rods capable of rapid multiplication of very large numbers. In the lower left image, for example, the bones are set up to multiply in the quadrillions!

NO. 7 THE INVENTION OF BINARY ARITHMETIC

LEIBNIZ, Gottfried Wilhelm, 'Nouvelle arithmetique binaire' [WITH:] 'Explication de l'arithmétique binaire, qui se sert des seuls caracteres 0 & 1', in *Histoire de l'Academie des Sciences, avec les Mémoires, Année MDCCIII* (Jean Boudot, Paris), 1705

172 x 120mm; pp. 58–63 (*Histoire*), pp. 85–89 (*Memoires*) [whole volume offered]

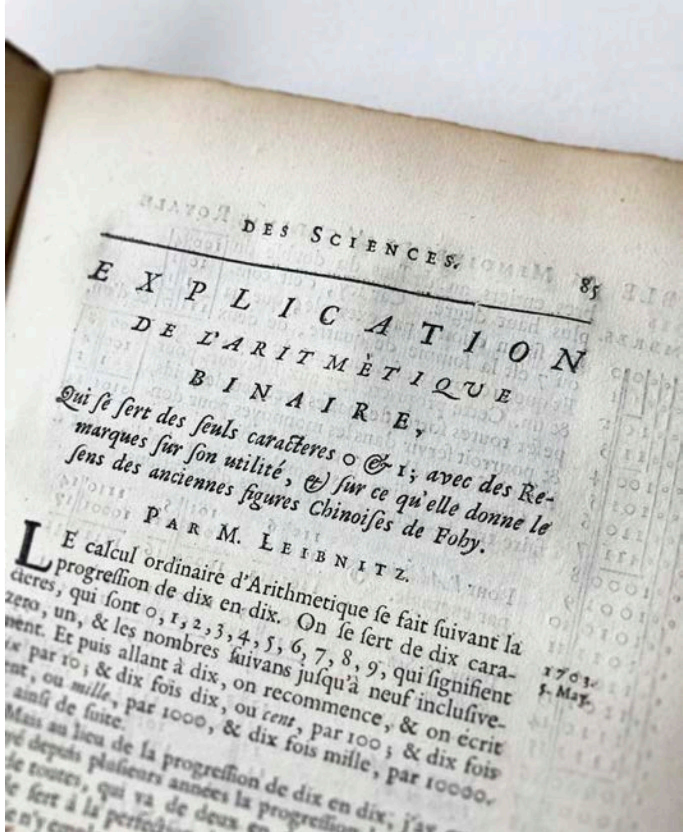
Good condition: neatly rebacked, with new endpapers

£5,950

THE LANGUAGE OF MODERN COMPUTING. Here Leibniz proposes and explores a base-2 numeral system, first introducing the concept and then discussing the nature of binary arithmetic, and its relation to the ancient Chinese divination text the I Ching (易經), or 'Book of Changes'.

Binary notation had been mentioned before Leibniz, but only as part of an inquiry into different base systems. Leibniz was the first to explore the binary system and to explain its arithmetic, and is rightly considered the inventor of the form of arithmetic that lies behind all modern computing (for more on this see the Introduction to Lloyd Strickland and Harry Lewis, *Leibniz on Binary: The Invention of Computer Arithmetic* [MIT Press, 2022]).

Although Leibniz's first work on binary dates from the late 1690s, this 1705 edition of the *Histoire* and *Mémoires* of the Academie des Sciences is the first public presentation of this pathbreaking work.


DES SCIENCES. 85

EXPLICATION DE L'ARITMÉTIQUE BINAIRE,

Qui se sert des seuls caracteres 0 & 1; avec des Remarques sur son utilité, & sur ce qu'elle donne le sens des anciennes figures Chinoises de Fohy.

PAR M. LEIBNITZ.

Le calcul ordinaire d'Arithmetique se fait suivant la progression de dix en dix. On se sert de dix caracteres, qui sont 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, qui signifient zero, un, & les nombres suivans jusqu'à neuf inclusivement. Et puis allant à dix, on recommence, & on écrit dix par 10; & dix fois dix, ou *cent*, par 100; & dix fois cent, ou *mille*, par 1000, & dix fois mille, par 10000. ainsi de suite.

1703. 5. May.

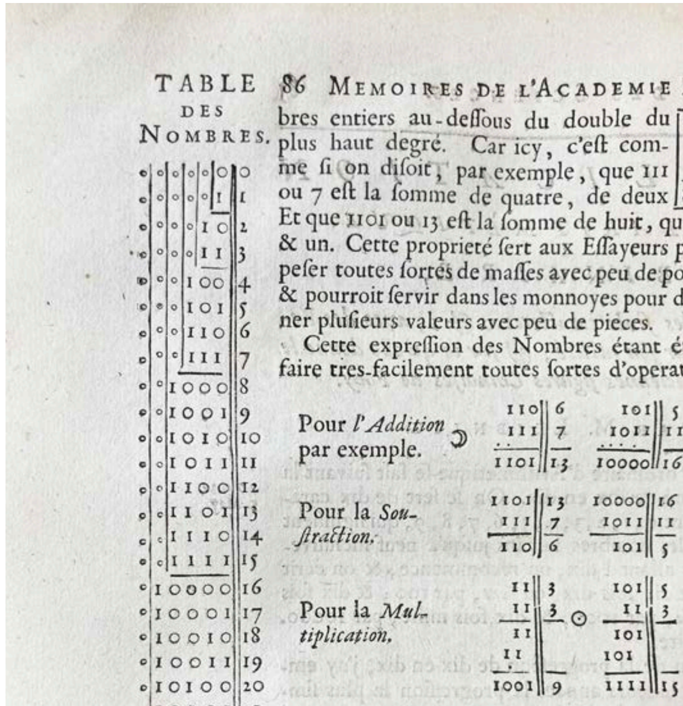


TABLE DES NOMBRES.

86 MEMOIRES DE L'ACADEMIE

bres entiers au-dessous du double du plus haut degré. Car icy, c'est comme si on disoit, par exemple, que 111 ou 7 est la somme de quatre, de deux Et que 1101 ou 13 est la somme de huit, & un. Cette proprieté sert aux Essayeurs peser toutes sortes de masses avec peu de & pourroit servir dans les monnoyes pour ner plusieurs valeurs avec peu de pieces.

Cette expression des Nombres étant faire tres-facilement toutes sortes d'opera

Pour l'Addition par exemple.

Pour la Soustraction.

Pour la Multiplication.

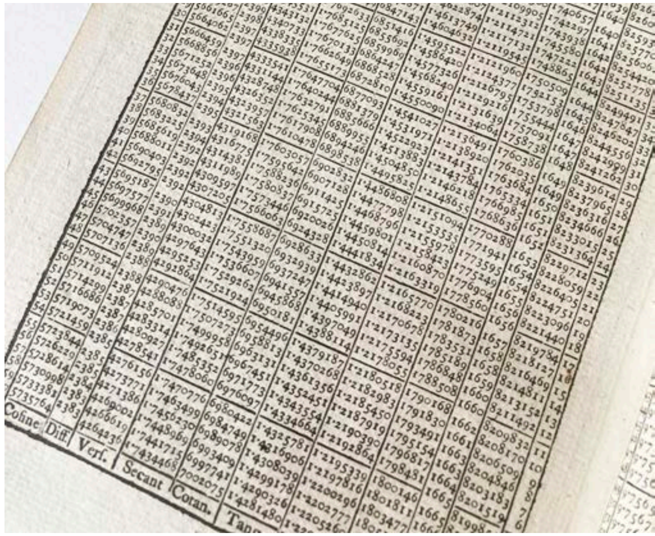
NO. 8 WHEN COMPUTERS WERE HUMAN: FIRST EDITION OF HUTTON'S MATHEMATICAL TABLES

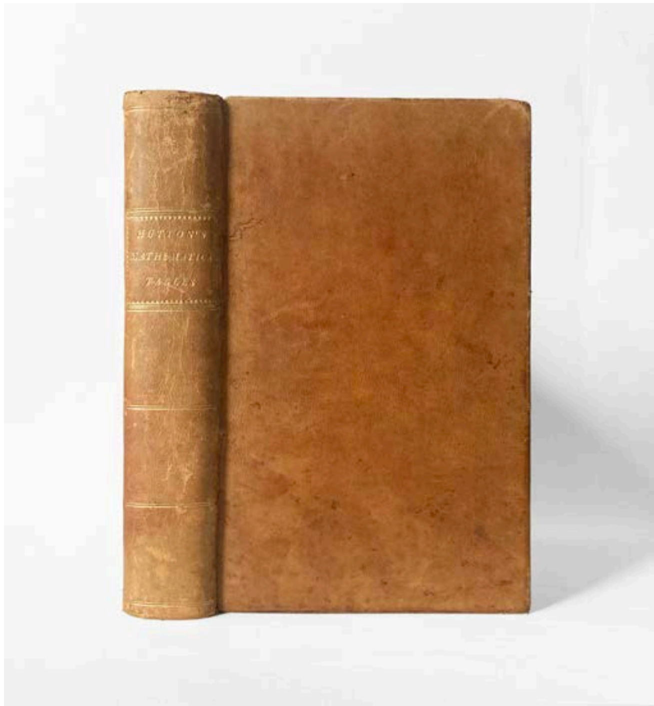
HUTTON, Charles, [ORD, Margaret], *Mathematical Tables: Containing Common, Hyperbolic, and Logistic Logarithms. Also Sines, Tangents, Secants, And Versed-Sines [...]* (G.G.J. and J. Robinson, and R. Baldwin, London), 1785

Small 4to; pp. xii, 343

Very good condition: early full calf binding with gilt spine title and bands; internally very good throughout, noting only some very sparse spotting and a few minor ink marks

[SOLD]





SCARCE FIRST EDITION of hutton's famous set of mathematical tables, one of the monuments of calculation of the eighteenth century – and an important monument to the role of women in the history of computing (see also No. 23).

Charles Hutton was a mathematics teacher and then professor, at the Royal Military Academy in Woolwich. His long interest in producing mathematical tables led naturally to the desire to replace the notoriously innacurate set of calcuations produced by Henry Sherwin. To undertake the extraordinarily laborious task of calculating logarithms, Sherwin enlisted his second wife Margaret Ord, and possibly also his daughter Isabella (see Benjamin Wardhaugh, *Gunpowder and Geometry: The Life of Charles Hutton*). The work is also notable for its very extensive technical introduction, which gives a complete history of the calculation of logarithms up to Hutton's time.

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NO. 9 'MR BABBAGE'S INVENTION': THE BIRTH OF AUTOMATIC COMPUTING

[BABBAGE, Charles], *Mr. Babbage's Invention. Copies of the Correspondence Between the Lords Commissioners of His Majesty's Treasury and the President and Council of the Royal Society, relative to an Invention of Mr. Babbage* (Ordered by the House of Commons to be printed, [London]), 1823

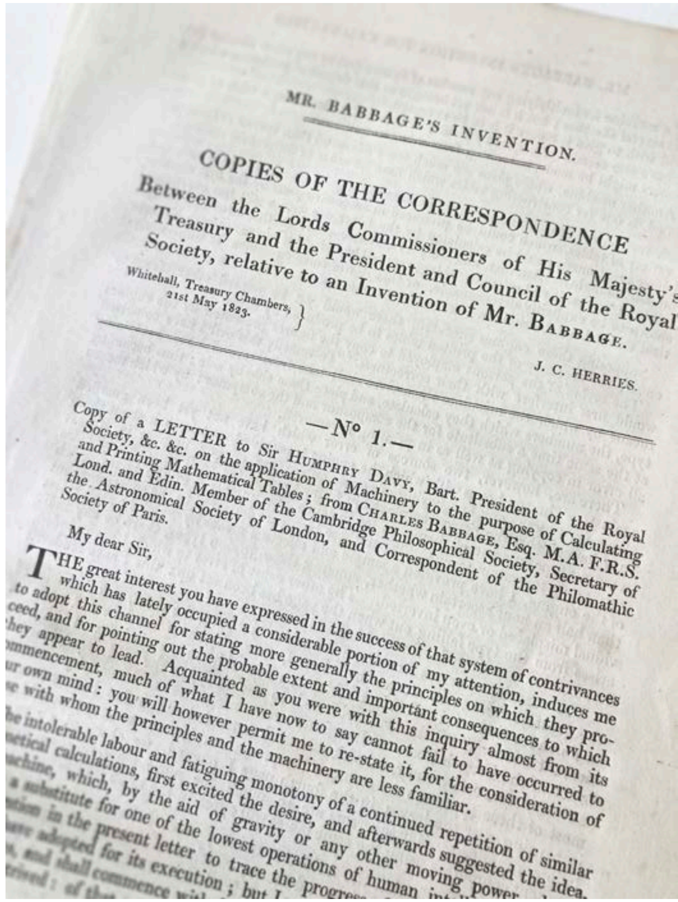
Folio; pp. [8]

Near fine condition: stab-stitched as issued; docket title printed orthoganally to rear of last sheet (see top image); presented in an attractive large-format folder with a paper title to the cover

£5,500

An exceptionally scarce and important document in the history of computing. This is the sole separate printing of the parliamentary record (*Sessional Papers*) containing Babbage's celebrated letter to Humphry Davy, as well as the favourable response of the Royal Society. Only one other copy is recorded worldwide, at the University of Illinois.

Although many calculating machines predate Babbage's Difference Engine, the Engine marks a decisive break: Babbage wanted not only to mechanize calculation, but to automate it. Specifically he wanted to automate the compilation and printing of astronomical and other mathematical tables (see No. 8).


MR. BABBAGE'S INVENTION.

COPIES OF THE CORRESPONDENCE

Between the Lords Commissioners of His Majesty's Treasury and the President and Council of the Royal Society, relative to an Invention of Mr. BABBAGE.

Whitehall, Treasury Chambers, 21st May 1823.

J. C. HERRIES.

— No 1. —

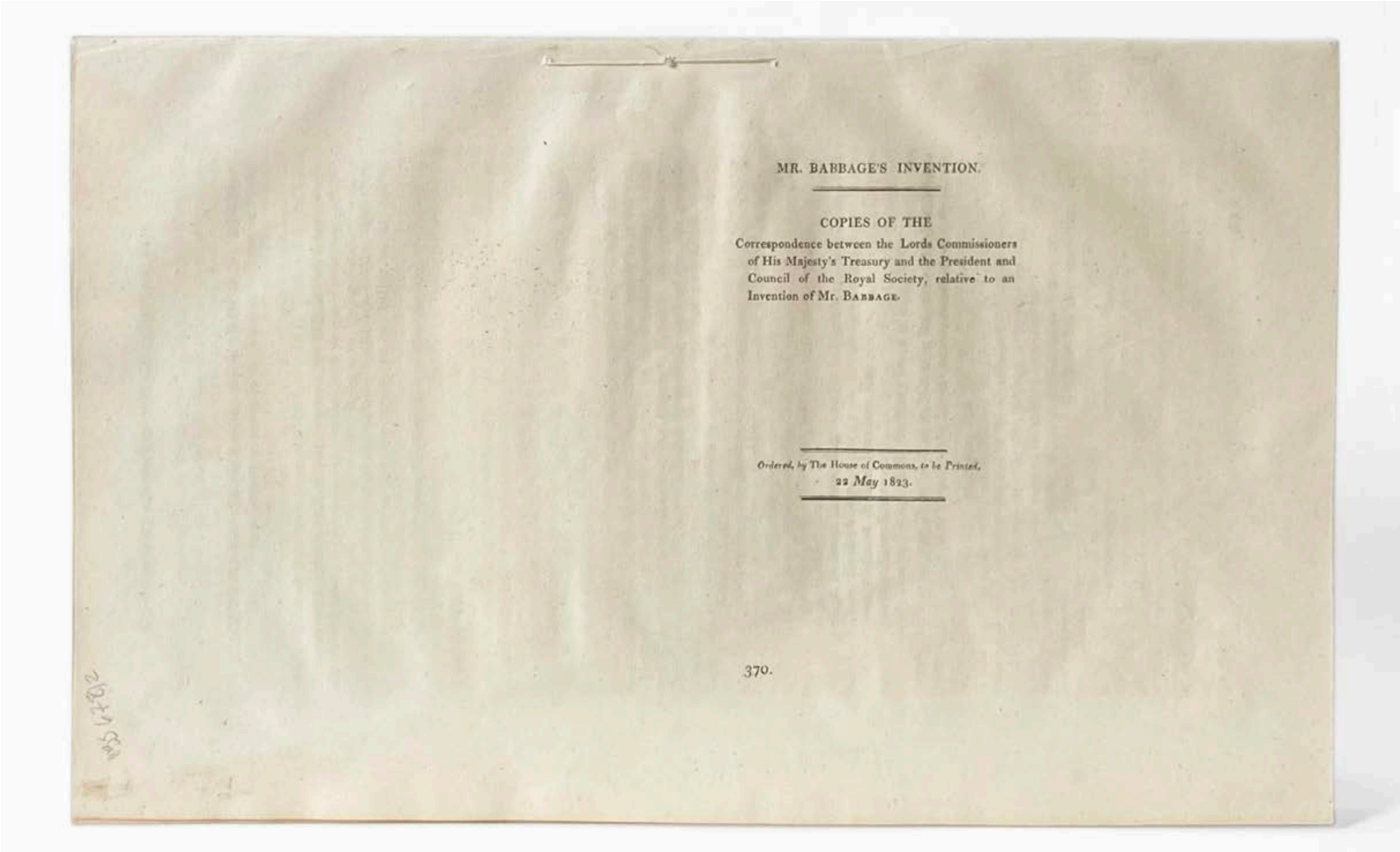
Copy of a LETTER to Sir HUMPHRY DAVY, Bart. President of the Royal Society, &c. &c. on the application of Machinery to the purpose of Calculating and Printing Mathematical Tables; from CHARLES BABBAGE, Esq. M.A. F.R.S. Lond. and Edin. Member of the Cambridge Philosophical Society, Secretary of the Astronomical Society of London, and Correspondent of the Philomathic Society of Paris.

My dear Sir,

(continued overleaf)

BJRB

The present document marks the moment when Babbage's Difference Engine went from an inventor's dream to a reality – albeit one only ever partially completed. Having created a model of his Difference Engine in the early 1820s, Babbage sought public support, writing with extensive detail of the project to the most famous scientist in the land – Humphry Davy. The Royal Society's response was decisive: a grant to Babbage was made, and production began in earnest.



MR. BABBAGE'S INVENTION.

COPIES OF THE

Correspondence between the Lords Commissioners of His Majesty's Treasury and the President and Council of the Royal Society, relative to an Invention of Mr. BABBAGE.

Ordered, by The House of Commons, to be Printed, 22 *May* 1823.

370.

NO. 10 THE DIFFERENCE ENGINE IN THE SATURDAY MAGAZINE

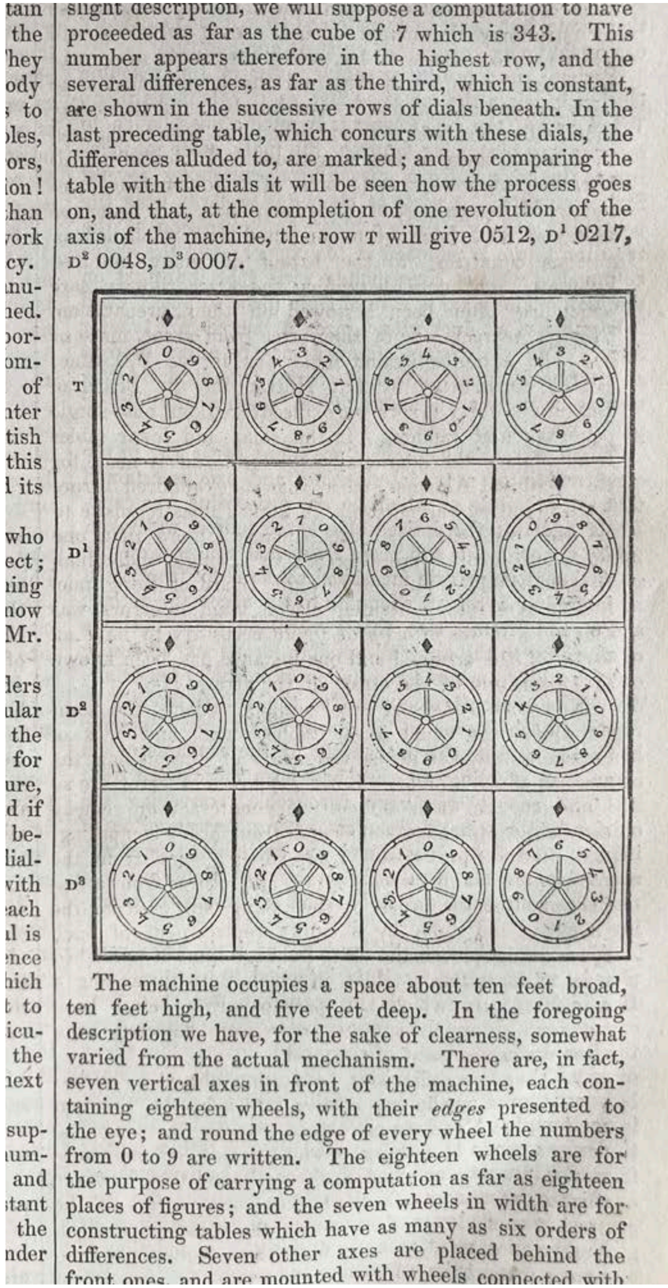
[Anon.], 'Babbage's Calculating Machine', in *The Saturday Magazine*, Vol. xviii, No. 552 (John W. Parker, London), 1841

189 x 281mm; [various paginations, whole volume offered, Babbage pp. 52–54 of No. 552

Very good condition: attractive half-leather binding with marbled boards; title-page somewhat marked, especially to the outer margin; generally very good internally

£250

One of the most comprehensive early descriptions of the Difference Engine. Babbage's invention was designed to automate the calculation and even printing of mathematical tables (see No. 8). Through the 1820s Babbage and his collaborator Joseph Clement received generous government funding (see No. 9) – the total spent is estimated to be around £17,000 (up to 1842). Babbage's engine works by the method of divided differences, and by the mid-1830s a small version was able to operated on 6-digit numbers by second-order differences. However, the collosal cost and engineering problems encountered caused Babbage to abandon the project soon after this publication – which reports on the Difference Engine in glowing terms. His attention also shifted to the even more ambitious Analytical Engine.



slight description, we will suppose a computation to have proceeded as far as the cube of 7 which is 343. This number appears therefore in the highest row, and the several differences, as far as the third, which is constant, are shown in the successive rows of dials beneath. In the last preceding table, which concurs with these dials, the differences alluded to, are marked; and by comparing the table with the dials it will be seen how the process goes on, and that, at the completion of one revolution of the axis of the machine, the row T will give 0512, D^1 0217, D^2 0048, D^3 0007.

The machine occupies a space about ten feet broad, ten feet high, and five feet deep. In the foregoing description we have, for the sake of clearness, somewhat varied from the actual mechanism. There are, in fact, seven vertical axes in front of the machine, each containing eighteen wheels, with their *edges* presented to the eye; and round the edge of every wheel the numbers from 0 to 9 are written. The eighteen wheels are for the purpose of carrying a computation as far as eighteen places of figures; and the seven wheels in width are for constructing tables which have as many as six orders of differences. Seven other axes are placed behind the front ones, and are mounted with wheels connected with

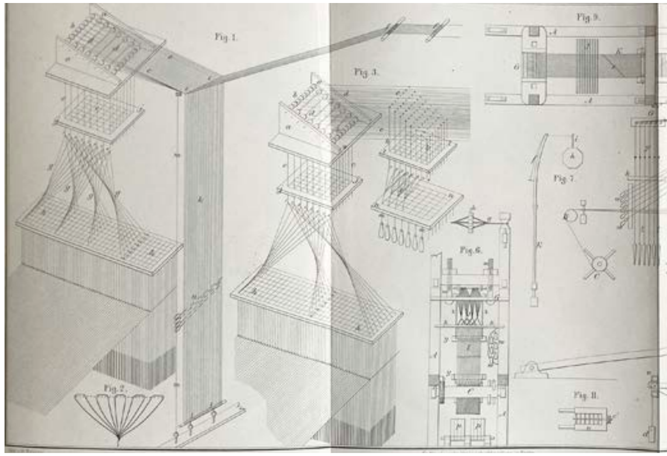
NO. 11 THE ORIGIN OF PUNCHED CARDS: IMPORTANT TECHNICAL TREATISE ON THE JACQUARD LOOM

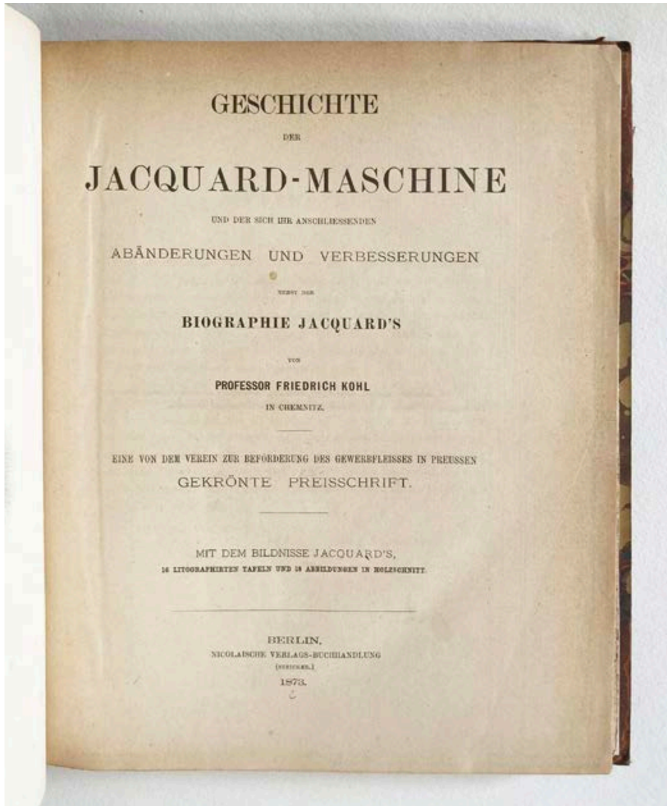
KOHL, Friedrich, *Geschichte der Jacquard-Maschine und der sich ihr anschliessend-en Abänderungen und Verbesserungen* (Nicolaische Verlags-Buchlandlung, Berlin), 1873 [second issue]

225 x 279mm; pp. [frontis. portrait; 2 leaves, [1]–197, [1], [16 folding plates]

Good condition: neatly rebacked; some spotting to frontis.; neat early marginal repair to prelims; paper fragile but unmarked; plates excellent

[SOLD]





THE DEFINITE ACCOUNT OF THE JACQUARD LOOM. At first sight perhaps an unusual landmark in the history of computing. However, the Jacquard loom was the first device to be automatically operated by means of punched cards, which stored information on woven designs. Charles Babbage, in the unrealised design for an 'Analytical Engine' proposed using punched cards – and the idea was taken up in earnest by Herman Hollerith at the beginning of the 20th century.

By the middle of the twentieth century punched cards were the substrate of data processing. At Bletchley Park, for example, approximately 2 million punched cards a week were being produced. Punched cards were ubiquitous in computing until the 1980s, when new input technologies began to replace them.

This treatise gives a very throughough description of the Jacquard loom, illustrated with 16 fine and large technical plates.

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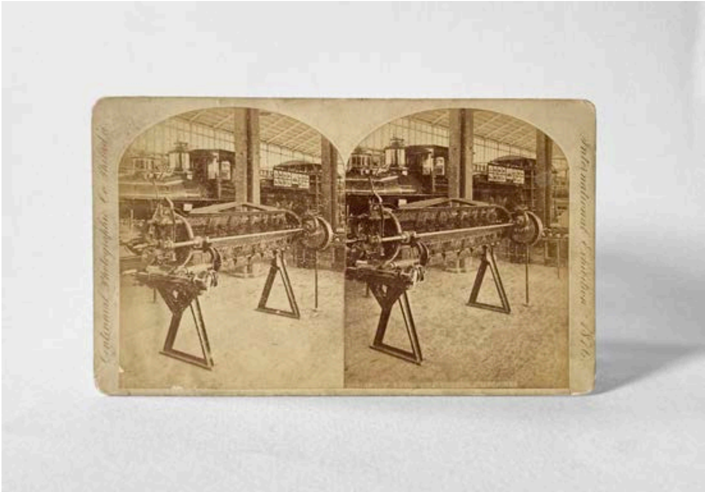
NO. 12 STEREOVIEW OF GEORGE B. GRANT'S DIFFERENCE ENGINE

Stereoview of George B. Grant's Difference Engine
Issued by the Centennial Photographic Company, Philadelphia, 1876

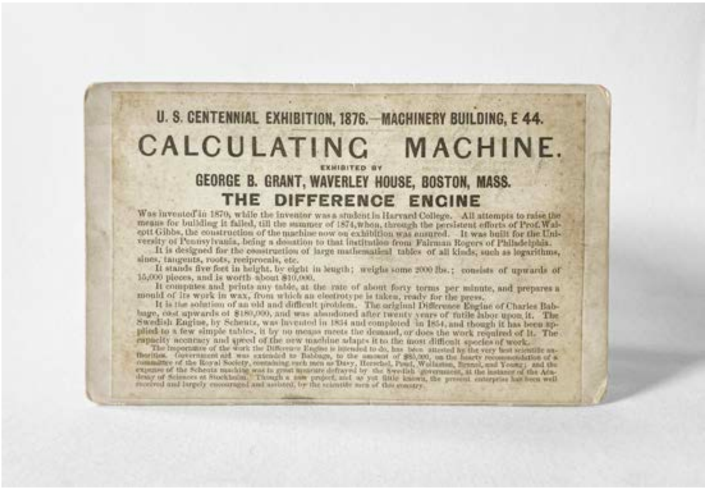
185 x 142mm

Good condition: spine worn at top and bottom, with some loss to the bottom; top-right corner of the cover nicked; internally very good; paper fragile

[ON RESERVE]



RARE STEREOVIEW OF AN EARLY DIFFERENCE ENGINE. After Babbage's abortive attempt to create a Difference Engine in the 1820s and 1830s, a number of other inventors and engineers attempted the task. Amongst them was George B. Grant, who began his work at Harvard in the 1860s, ignorant of his predecessors. Soon Grant learned of the experiments of Babbage and also and Per Georg Scheutz, and was able to succeed where Babbage had failed, completing a Difference Engine in the mid 1870s – the first to be made in the US. This stereoview shows the machine on display at the Centennial Exposition in Philadelphia.



Examples of Grant's other calculating machine are held in various collections – yet the difference engine appears not to have survived, making this 3D image all the more significant. We have not been able to locate any other copies of this stereoview in collections worldwide.

NOS. 13/14 GENAILLE'S RODS: NAPIER'S BONES AUTOMATED

GENAILLE, Henri, and LUCAS Edouard, *Les Réglettes Multiplicatrices, Appareils à Calculs Exacts et Instantanés pour Simplifier la Multiplication et la Division* (Eugène Belin, Paris), 1885

[and:]

GENAILLE, Henri, and LUCAS Edouard, *Les Réglettes Financières, Appareils à Calculs Exacts et Instantanés pour Simplifier les Calculs Financiers et Commerciaux* (Eugène Belin, Paris), 1885

120 x 181 x 13mm (both cases identical); eleven rods in each set, printed on all four sides, housed in a card boxes with printed 'titles'

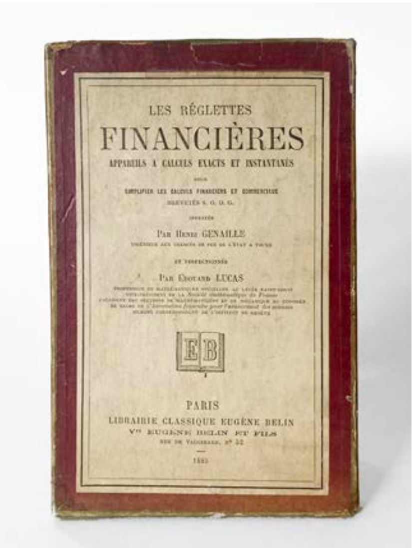
Very good condition: both sets complete; rods very good indeed; light wear to the box edges, and a few marks to the front covers

***Multiplicatrices*: [SOLD]**
***Financières*: £2,800**

TWO VISUALLY STUNNING SETS OF 'GENAILLE'S RODS'. The first set is a perfected form of Napier's Bones (see No. 6) for multiplication and division. The wood rods are covered on all four sides with printed paper columns, and are used in conjunction with the fixed rod. The results are instantaneous, for numbers as large as ten digits. These rather complex rods each present, using the four sides, tables and

(continued overleaf)

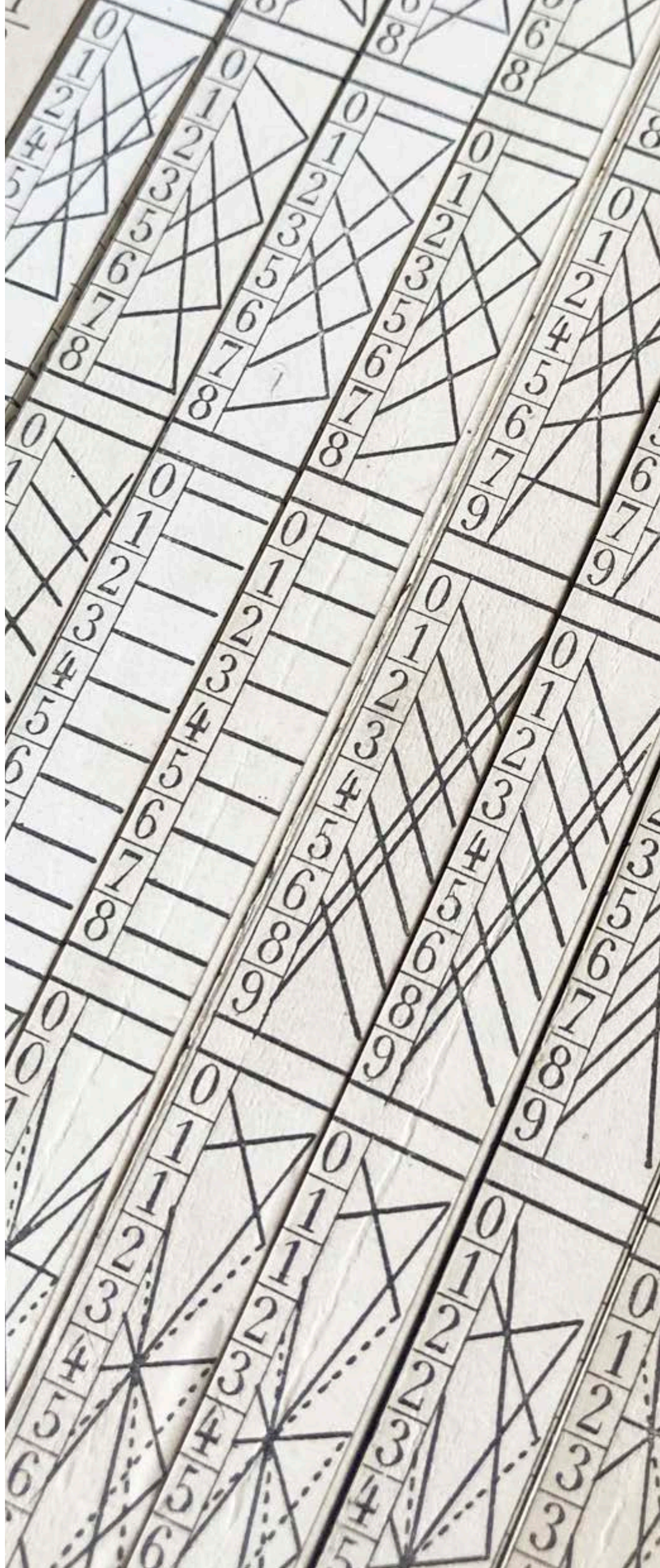
diagrams for four different digits (identified on the top and bottom of each rod). There are nine rows, aligning with the numerals 2 through 9 on the left-most (fixed) rod. Black triangles align with graded columns of digits to give multiplication tables, etc. In use, for multiplication one simply selects the rods to form any multiplicand, starts with the right-most digit, and follows the path of the triangles to read out the result.



The second set is adapted for performing financial calculations, specifically those having to do with the computation of interest.

The rods have their origin in the work of the mathematician Edouard Lucas, who posed a mathematical problem to the Académie française. In the course of solving the problem the engineer Genaille invented this new form of Napier's Bones, and went on to create a variety of specific sets.

All such sets are rare, especially complete and in such good condition.



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NO. 15 A FINE ARITHMOMETER, MADE UNDER THE DIRECTION OF (MADAME) VEUVE PAYEN

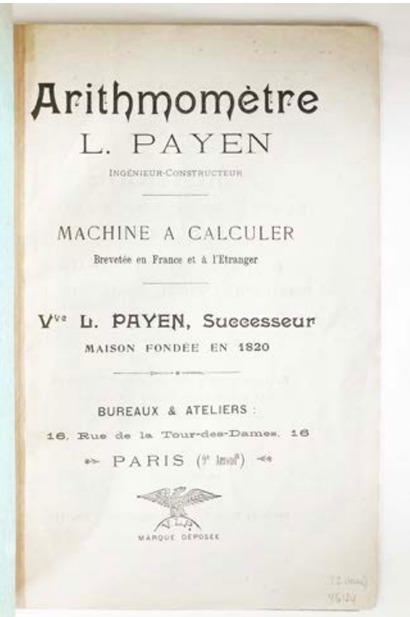
A Fully Operational Arithmomer
By Veuve Payen, French, *c.*1910

635 x 203 x 152mm (case when closed)

Very good condition: housed in the original fitted wooden case; fully working; brass retains most of the original lacquer; some wear to the case

£3,250

THE HIGH-POINT OF BUSINESS CALCULATING MACHINES. An excellent example of the Payen arithmometer, made under the direction of Veuve Payen, with the original manual and trade literature. The arithmometer was the first widely available, general purpose calculating machine.



The arithmometer was developed in the early years of the nineteenth century by Thomas de Colmar, but the mechanical calculator industry really took off in the late-19th century, with Payen the leading manufacturer. After Louis death in 1902 the firm was taken over by his widow Veuve Payen, who reset the serial numbering to 500 and successfully carried on business until 1915.

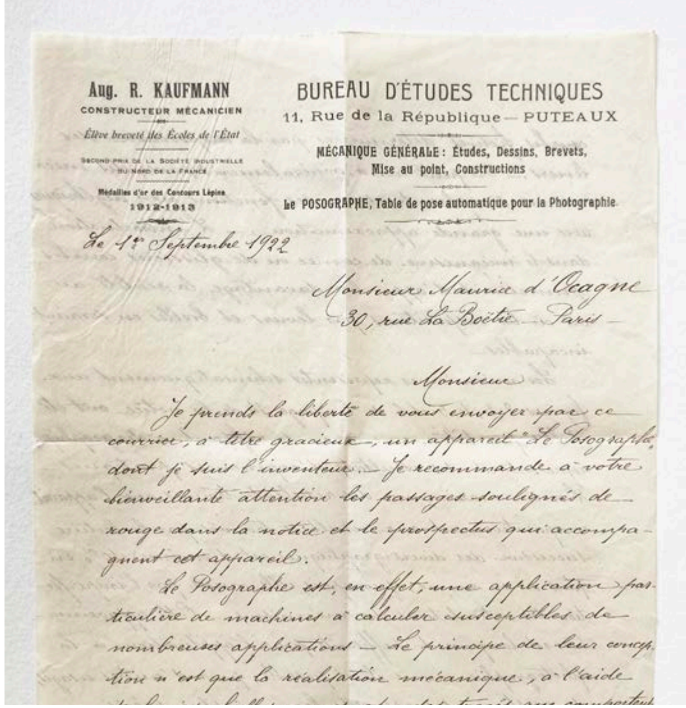
NO. 16 THE INGENIOUS POSOGRAPHE: WITH A LETTER FROM THE INVENTOR

'Posographe' Analog Computer (with booklet, and a letter from the inventor)
By Auguste-Robert Kafmann, *c.*1922

98 x 139 x 12mm (cased posographe); leaflet 100 x 130mm; letter is a single sheet, 257 x 270mm

Near fine condition: Posographe in its original case; fully functioning; leaflet very good; letter folded but very good

£1,750



Aug. R. KAUFMANN
CONSTRUCTEUR MÉCANICIEN
Élève breveté des Écoles de l'État
SECOND PRIX DE LA SOCIÉTÉ INDUSTRIELLE DU NORD DE LA FRANCE
Médailles d'or des Concours Lépine 1912-1913

BUREAU D'ÉTUDES TECHNIQUES
11, Rue de la République — PUTEAUX
MÉCANIQUE GÉNÉRALE: Études, Dessins, Brevets, Mise au point, Constructions
Le POSOGRAPHE, Table de pose automatique pour la Photographie

Le 1er Septembre 1922

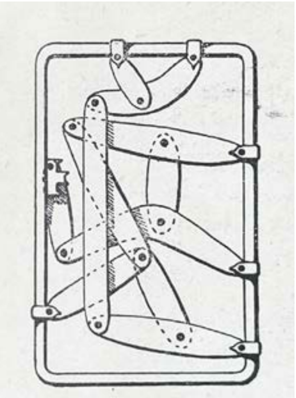
Monsieur Maurice d'Ocagne
30, rue La Boëtie — Paris —

Monsieur

Je prends la liberté de vous envoyer par ce courrier, à titre gracieux, un appareil "Le Posographe", dont je suis l'inventeur. — Je recommande à votre bienveillante attention les passages soulignés de rouge dans la notice et le prospectus qui accompagnent cet appareil.

Le Posographe est, en effet, une application particulière de machines à calculer susceptibles de nombreuses applications — Le principe de leur conception n'est que la réalisation mécanique, à l'aide

ONE OF THE MOST ELEGANT ANALOG COMPUTERS EVER MADE. The Posographe is a photographer's exposure computer – one side works for indoor and the other for outdoor conditions. The user inputs various information – level of sunlight, colour of the walls, etc. – and the internal mechanism delivers an exposure time. In computing terms, the Posographe calculates two discrete functions of six variables each – all in a pocket-sized instrument without a single gearwheel. This incredible piece of engineering was patented by Kaufmann in May 1922. This early example is accompanied by an important letter from Kaufmann, dated 1 September 1922. The letter is addressed to Maurice d'Ocagne, inventor of the Nomogram, and in it Kaufmann explains the Posographe and even sheds valuable light on how he created the brilliant internal mechanism (see image to the left).



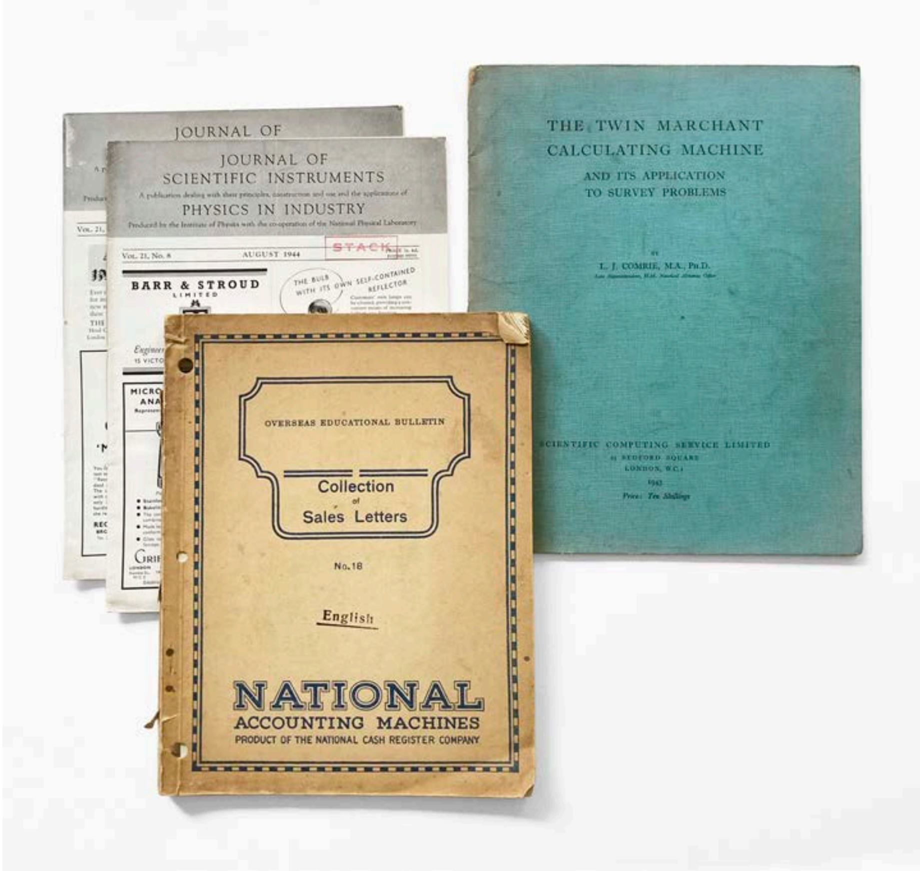
Vue schématique du mécanisme intérieur

NO. 17 ‘A MODERN BABBAGE MACHINE’: L.J. COMRIE ON SCIENTIFIC COMPUTING (4 EPHEMERAL ITEMS)

COMRIE, L.J., [An article in the *Journal of Scientific Instruments*, with susequent issue featuring further correspondence; *The Twin Marchant Calculating Machine and Its Application to Survey Problems*; ‘Collection of Sales Letters’ for the National Accounting Machine], *c.*1930–1944

Generally good condition: all edges worn; spine of the National Accounting Machine document damaged at top and bottom

£450



A GROUP OF MATERIALS relating to L.J. Comrie’s pioneering experiments in ‘scientific computing’, which involved ‘hacking’ existing calculating machines to turn them into *ad hoc* programmable computers. The earliest document is an unusual and extremely rare collection of sample sales letters for the National Accounting Machine (no date but *c.*1930). The letters explain the utility of the machine in a wide range of fields. Comrie’s ingenious hijacking of this device relied turned it into what he called a ‘Modern Babbage Machine’. This adaptation of the National Accounting Machine is described in the journal article ‘Recent Progress in Scientific Computing’, offered here, together with a related issue of the *JSI*. The final document is in effect a ‘manual’ for Comrie’s adaptation of the ‘Twin’ Marchant Calculating machine. In Comrie’s hands this instrument could have a wide range of applications in surveying – especially military survey. Comrie also gives an extended discussion of how to use the machine to solve problems in statistics, numerical analysis, etc.

NO. 18 THE MUSICAL SLIDE RULE

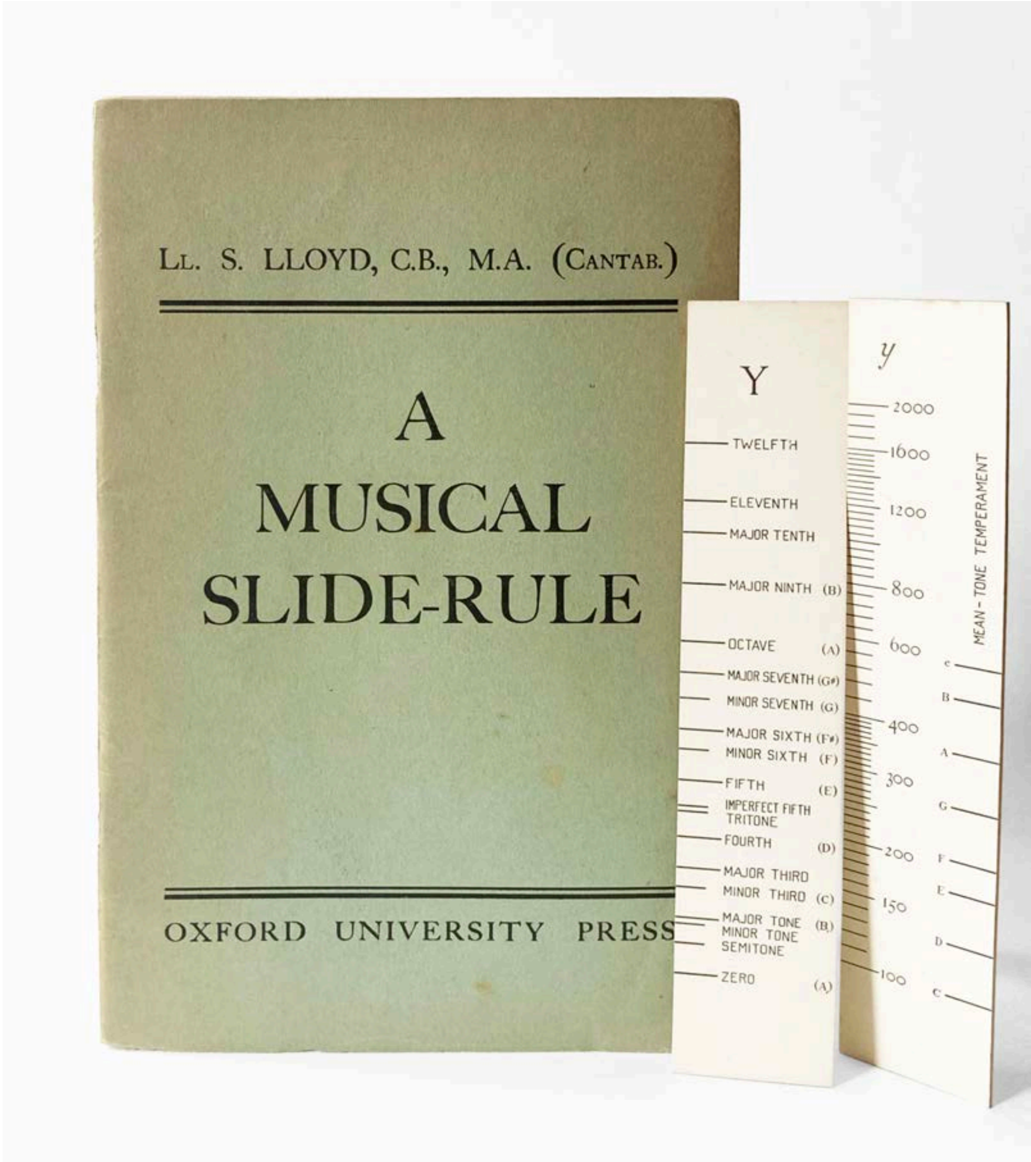
BJRB

LLOYD, Ll. S., A Musical Slide-Rule (Oxford University Press, Oxford), 1938

140 x 220mm; pp. 25 [two card rules inserted to rear cover pouch]

Very good condition: cover very slightly spotted; rear cover creased to the lower left corner; internally very good, noting only some rusting to the staples

£250



An unusual card musical slide rule. This attractive little booklet, with the two parts of the slide rule tucked into a pouch on the rear cover, offers "an introduction to the study of the musical scale employed by composers and skilled artists" (from the Preface).

The slide rule carries two sets of scales, one of which is logarithmic. Lloyd introduces the logarithmic scale first, therefore teaching a little bit of mathematics along with quite a lot of musical theory.

The relationship between music and mathematics is deep and long-standing. The use of calculating instruments in music is less well known. For a much earlier musical slide rule see No. 5 in this catalogue.

NO. 19 HARTREE DIFFERENTIAL ANALYZER

BJRB

HARTREE, D.R., 'The Mechanical Integration of Differential Equations', in *The Mathematical Gazette*, Vol. xxii, No. 251 (G. Bell and Sons, London), 1938

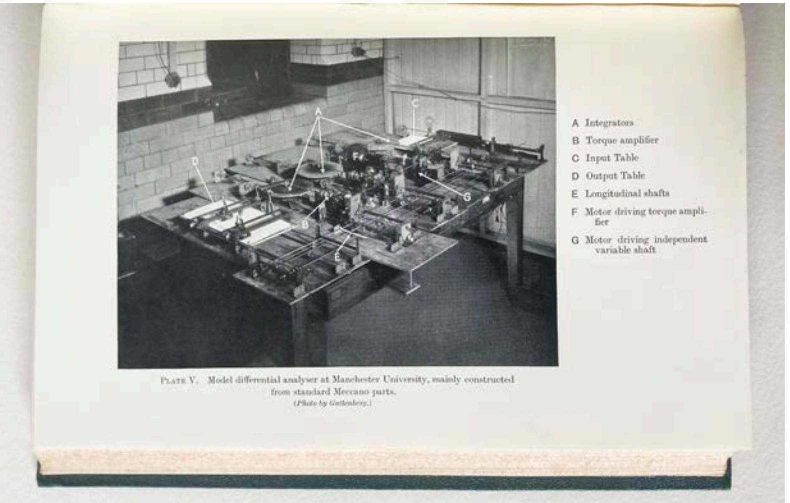
8vo; pp. xiii, 528; Hartree pp. 342–364 [whole volume offered]

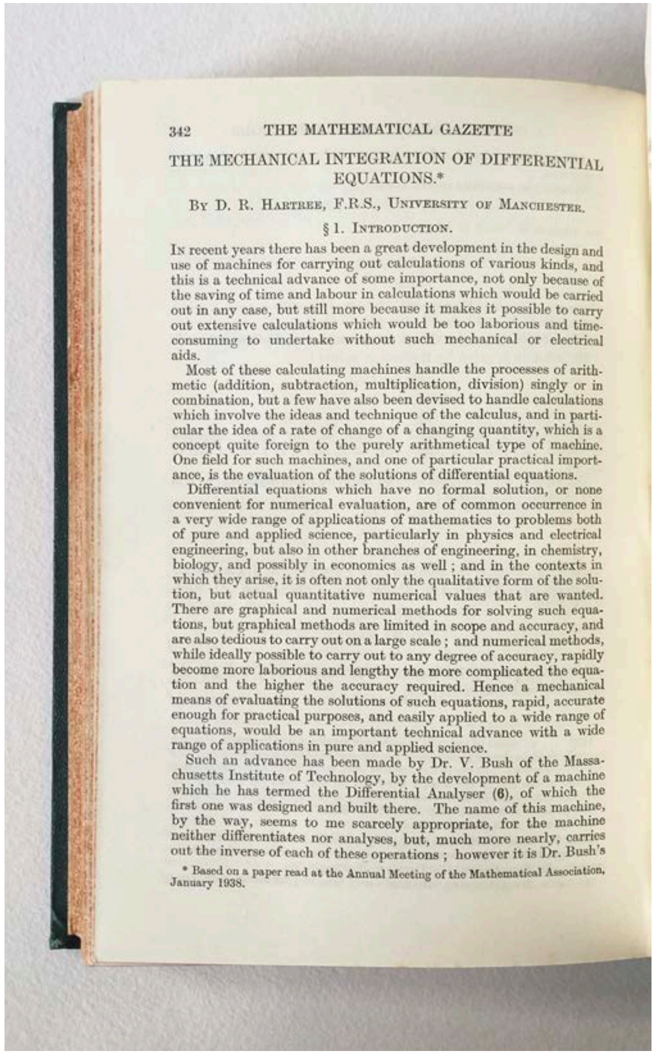
Very good condition in green cloth; clean and unmarked throughout, noting only very faint and very occasional foxing, barely affecting the Hartree essay

£200

HARTREE'S IMPORTANT ACCOUNT OF THE 'DIFFERENTIAL ANALYSER' with photographs of the manchester analyser, and hartree's pioneering Meccano model.

The most comprehensive of the early essays on the differential analyser, with diagrams and photographs illustrating the design, accounts of the use and applications of the machine, and a useful bibliography. The Differential Analyser was invented by Vannevar Bush, and first published in 1931; Bush's invention was the culmination of a line in computer design that goes back to the work of James and William Thomson (Lord Kelvin), most famously the latter's tide-predicting machine. The Differential Analyser was hugely successful, circulating around the world in the extraordinary Meccano version pictured here.





342 THE MATHEMATICAL GAZETTE

THE MECHANICAL INTEGRATION OF DIFFERENTIAL EQUATIONS.*

By D. R. Hartree, F.R.S., University of Manchester.

§ 1. Introduction.

In recent years there has been a great development in the design and use of machines for carrying out calculations of various kinds, and this is a technical advance of some importance, not only because of the saving of time and labour in calculations which would be carried out in any case, but still more because it makes it possible to carry out extensive calculations which would be too laborious and time-consuming to undertake without such mechanical or electrical aids.

Most of these calculating machines handle the processes of arithmetic (addition, subtraction, multiplication, division) singly or in combination, but a few have also been devised to handle calculations which involve the ideas and technique of the calculus, and in particular the idea of a rate of change of a changing quantity, which is a concept quite foreign to the purely arithmetical type of machine. One field for such machines, and one of particular practical importance, is the evaluation of the solutions of differential equations.

Differential equations which have no formal solution, or none convenient for numerical evaluation, are of common occurrence in a very wide range of applications of mathematics to problems both of pure and applied science, particularly in physics and electrical engineering, but also in other branches of engineering, in chemistry, biology, and possibly in economics as well; and in the contexts in which they arise, it is often not only the qualitative form of the solution, but actual quantitative numerical values that are wanted. There are graphical and numerical methods for solving such equations, but graphical methods are limited in scope and accuracy, and are also tedious to carry out on a large scale; and numerical methods, while ideally possible to carry out to any degree of accuracy, rapidly become more laborious and lengthy the more complicated the equation and the higher the accuracy required. Hence a mechanical means of evaluating the solutions of such equations, rapid, accurate enough for practical purposes, and easily applied to a wide range of equations, would be an important technical advance with a wide range of applications in pure and applied science.

Such an advance has been made by Dr. V. Bush of the Massachusetts Institute of Technology, by the development of a machine which he has termed the Differential Analyser (**6**), of which the first one was designed and built there. The name of this machine, by the way, seems to me scarcely appropriate, for the machine neither differentiates nor analyses, but, much more nearly, carries out the inverse of each of these operations; however it is Dr. Bush's

* Based on a paper read at the Annual Meeting of the Mathematical Association, January 1938.

NO. 20 ECKERT PUNCHED CARDS

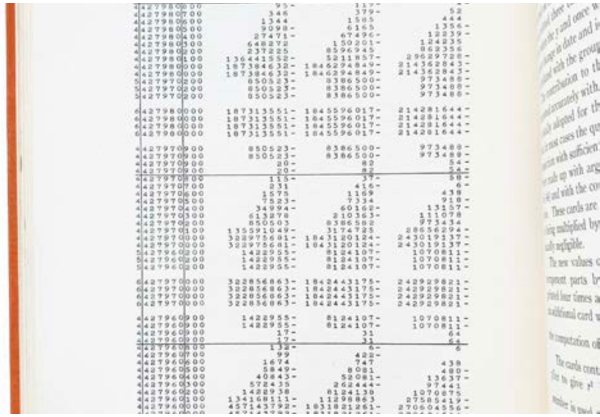
BJRB

ECKERT, W.J., *Punched Card Methods in Scientific Computation* (The Thomas J. Watson Computing Bureau, [New York], 1940)

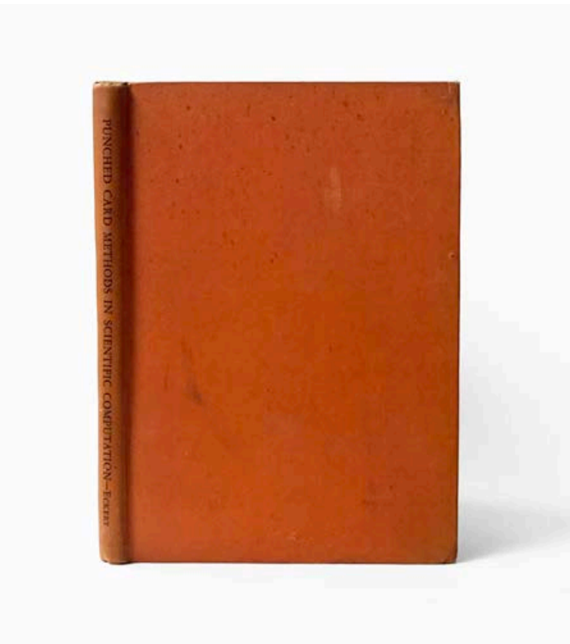
176 x 245mm; pp. 40

Good condition: orange cloth boards marked and bumped but still an attractive volume; small name stamp and faint pencil notes to front free endpaper

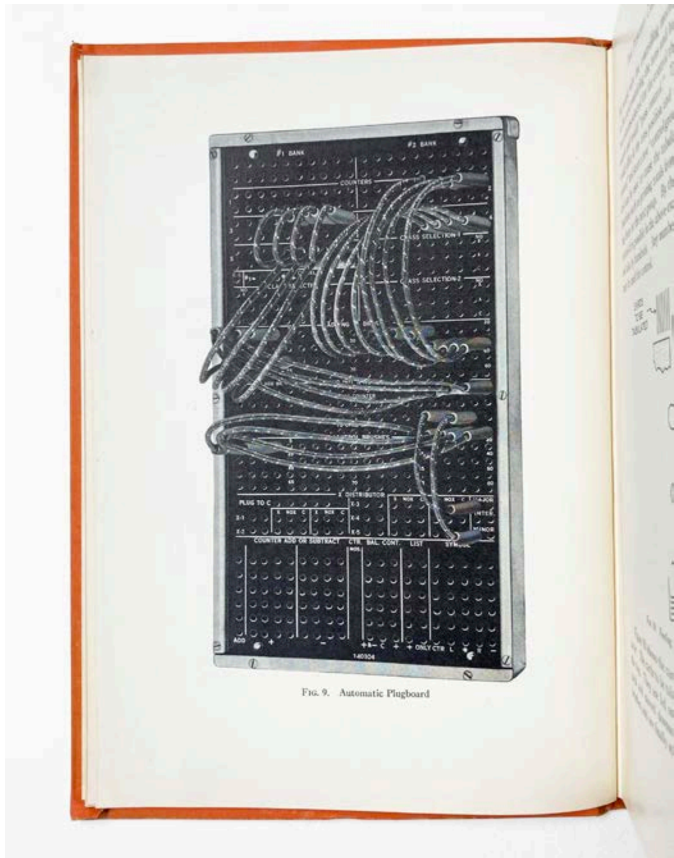
[SOLD]



The first book on scientific computing: Wallace Eckert was an astronomer at Columbia University. He was inspired by the work of L.J. Comrie (see No. 17), and in 1934 established the Thomas J. Watson Astronomical Computing Bureau at Columbia, which used IBM punched-card calculators. Eckert later described the Bureau as "the first scientific computing laboratory where general scientific calculations were performed automatically without any reading or writing of figures".



Eckert's ingenious use of calculating machines is here described in full for the first time, including his innovation of coding up to twelve operations onto a single card – a step towards the technique of 'sequence control' fully developed later for electronic digital computers.



NO. 22 'HE DID SOME STUNNING WORK FOR US': SHANNON ON CALCULATING MACHINES (2 TYPESCRIPTS)

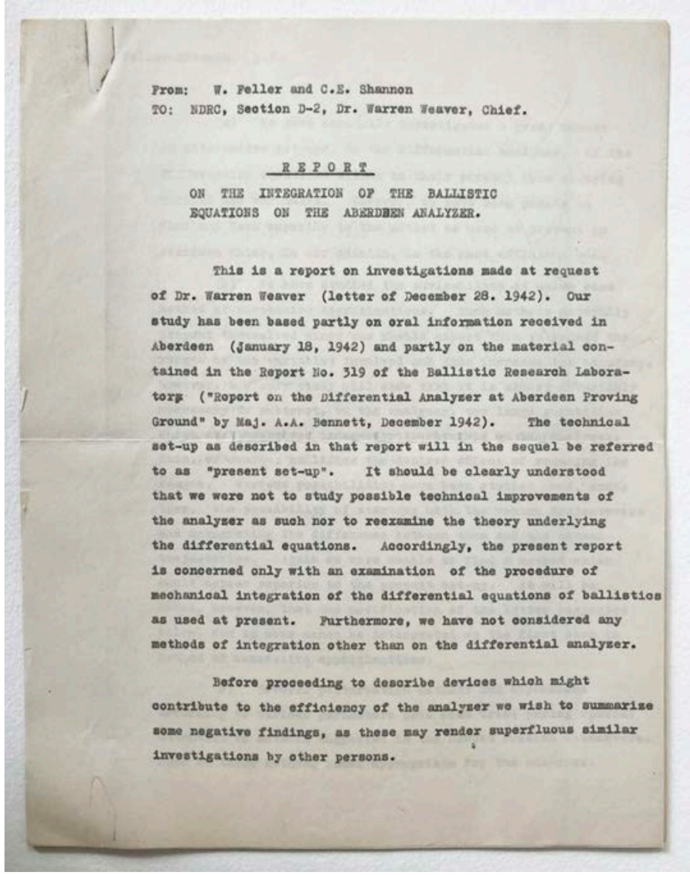
BJRB

SHANNON, Claude, and FELLER, W., 'A Study of the Deflection Mechanism and Some Results on Rate Finders', *circa* 10 February, 1941 [OFFERED WITH:] 'Report on the Integrations of the Ballistic Equations on the Aberdeen Analyzer', 27 May 1943

172 x 120mm; pp. 2-37 leaves + 15 figures on 8 leaves of plates ('Rate Finders') [1], 2-8 leaves ('Aberdeen Analyzer')

Very good condition; both documents are fragile but they are exceptionally well preserved; minor corrections and added diagrams and mathematical symbols to the 1943 report; minor damage to the edge of the cover sheet for the 1941 report, not affecting text

£3,750


From: W. Feller and C.E. Shannon
TO: NDRC, Section D-2, Dr. Warren Weaver, Chief.

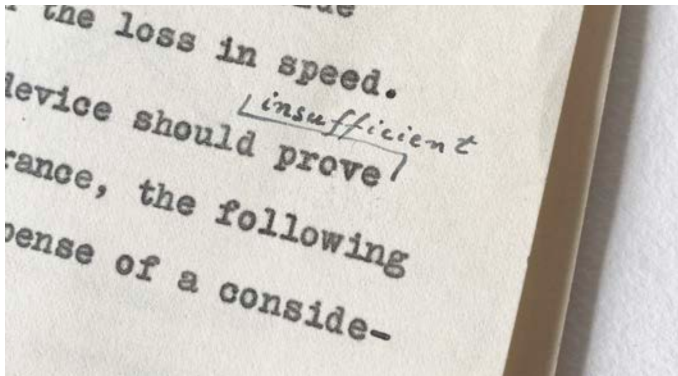
REPORT
ON THE INTEGRATION OF THE BALLISTIC
EQUATIONS ON THE ABERDEEN ANALYZER.

This is a report on investigations made at request of Dr. Warren Weaver (letter of December 28. 1942). Our study has been based partly on oral information received in Aberdeen (January 18, 1942) and partly on the material contained in the Report No. 319 of the Ballistic Research Laboratory ("Report on the Differential Analyzer at Aberdeen Proving Ground" by Maj. A.A. Bennett, December 1942). The technical set-up as described in that report will in the sequel be referred to as "present set-up". It should be clearly understood that we were not to study possible technical improvements of the analyzer as such nor to reexamine the theory underlying the differential equations. Accordingly, the present report is concerned only with an examination of the procedure of mechanical integration of the differential equations of ballistics as used at present. Furthermore, we have not considered any methods of integration other than on the differential analyzer.

Before proceeding to describe devices which might contribute to the efficiency of the analyzer we wish to summarize some negative findings, as these may render superfluous similar investigations by other persons.

TWO HIGHLY SIGNIFICANT REPORTS on differential analyzers by the founder of information theory and inventor of digital circuitry. These are Shannon's own retained copies. Both were prepared for the National Defense Research Committee, part of Shannon's well known wartime work on 'Fire Control' – that is, automatic defense systems (see Soni & Goodman, *A Mind at Play*, Ch. 9).

The first report (1941; images overleaf) is one of Shannon's earliest studies in this area, and gives a mathematical description of analog devices in use in gun aiming. The second (1943; images this page) concerns the 'Aberdeen Analyzer' – a version of the Bush type differential analyzer used at the Ballistics Research

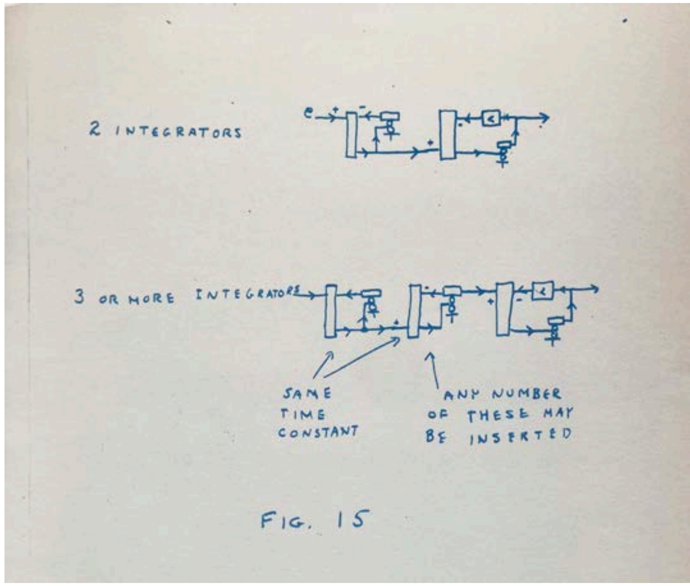


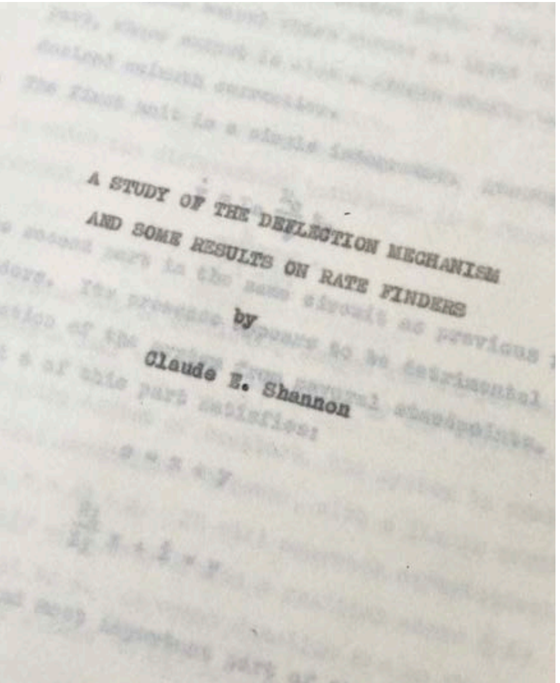
(continued overleaf)

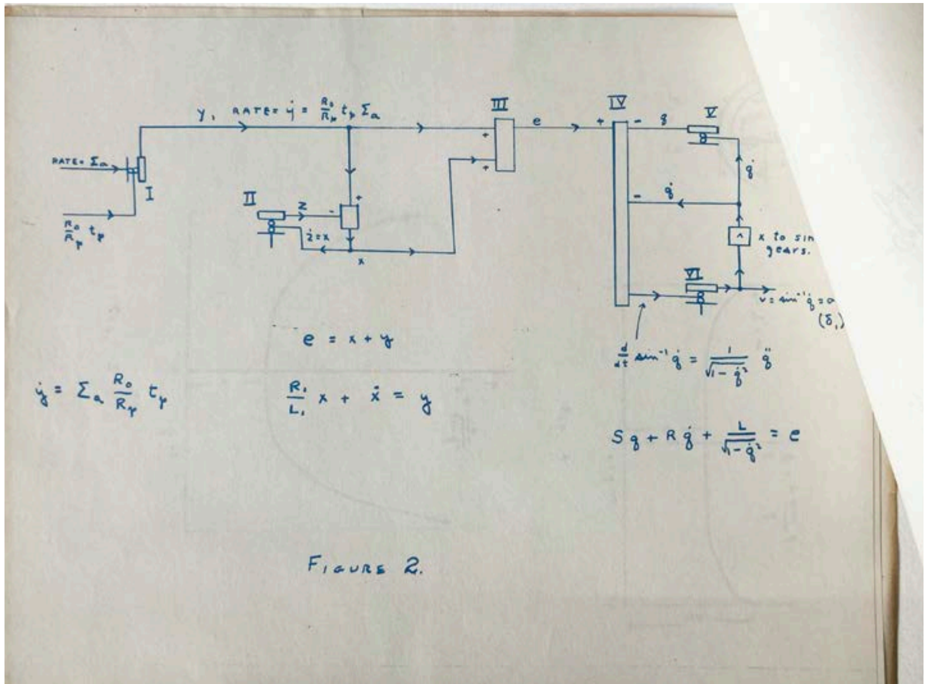
Laboratory at the army's Aberdeen Proving Ground in Maryland.

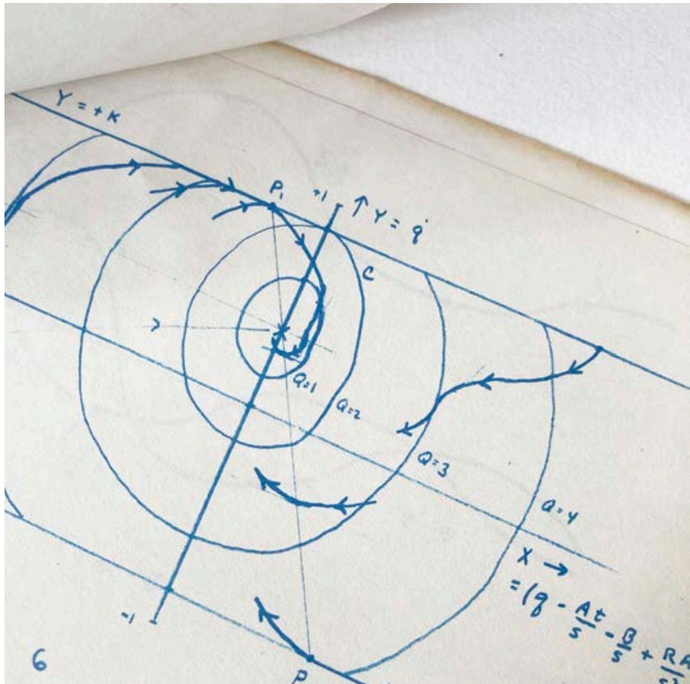
Shannon's breakthrough on these papers was to distill a mathematical theory of fire control out of the analysis of machines that were apparently designed to do the opposite, that is, to aim at a target rather than predict a trajectory. As Warren Weaver later put it, Shannon "did some stunning work for us." Soni and Goodman relate these studies to Shannon's later probabilistic thinking about information. David Mindell discusses Shannon's work in the context of the early development of cybernetics.

Neither report was published in Shannon's lifetime – no copies of either report can be found on WorldCat.




A STUDY OF THE DEFLECTION MECHANISM
AND SOME RESULTS ON RATE FINDERS
by
Claude E. Shannon





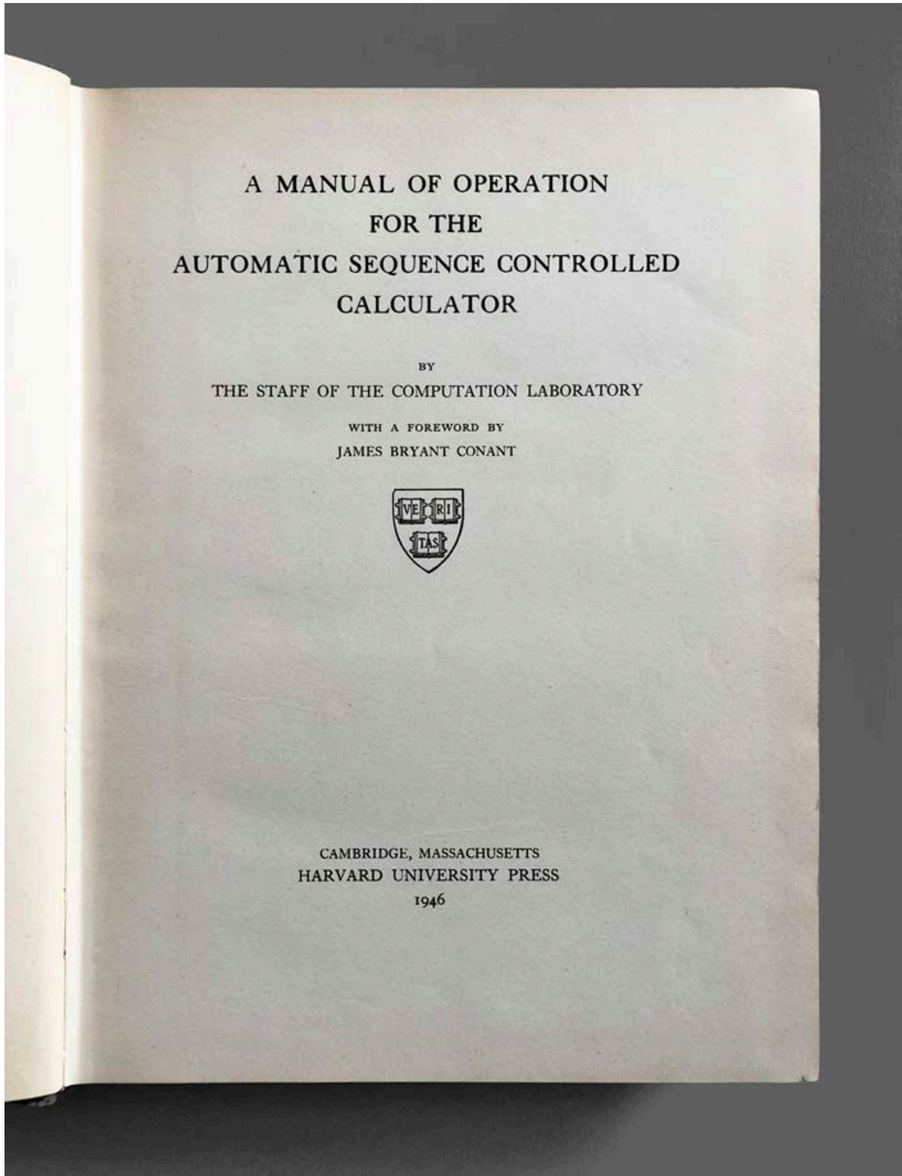
NO. 23 BABBAGE'S DREAM REALIZED

HOPPER, Grace Murray; AIKEN, Howard, *A Manual of Operation for the Automatic Sequence Controlled Calculator by the Staff of the Computation Laboratory* (Harvard University Press, Cambridge MA), 1946

210 x 275mm; pp. [13], 561, [17 full-page plates]

Good condition: spine blotchy, cloth binding worn; pencil notes to the first chapter, apparently copy-editorial and perhaps intended for a revised edition (no such edition was printed, however)

£4,250



THE FIRST MODERN COMPUTER MANUAL. The Automatic Sequence Controlled Calculator – ASCC, but generally known as the Harvard Mark I – was the first computer that could solve any arbitrary mathematical problem. By the time this manual was published the Mark I had already calculated a table of Modified Hankel Functions, thus realizing Charles Babbage's dream (see No. 9).

This manual, written by its inventor Howard Aiken and 'programmer' Grace Hopper, is the first book to contain computer programs. Hopper played a particularly important role in the history of coding, as she used her experience with the Mark I to become one of the very first inventors of a 'high level' programming language.

The Mark I is still on display at the Harvard Science Center.

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