A Decade After The End: A Slide Rule Instruction Book Published in 1984

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Abstract

As recently as 1984, a new slide rule instruction book was published in Moscow in the Russian language. The late date notwithstanding, it was clearly intended for technical people who would be performing actual calculations, not for curators of antique scientific instrument collections, nor for school children learning arithmetic. Covering several types of rules from several countries, it prominently featured a log-log decimal trig rule labeled 'Keuffel and Esser'. This raises questions about the timing of the end of the slide rule era, and about the last rules manufactured by Keuffel and Esser or based on their designs.

Introduction: The Received Chronology

It is widely understood that after more than three centuries, wherein the slide rule became standard equipment for engineers and scientists and, in less expensive forms, even for students, the slide rule era ended rather abruptly in the early 1970s.

As Izebrand Schuitema put it, "In the beginning of the 1970s the slide rule as a calculating aid suddenly disappeared from the scene. Its place was taken by the pocket calculator..." [34, page 2]. Or as Conrad Schure put it, "The demise of our beloved Slide Rules was brought about principally by the introduction of the pocket electronic calculator in the latter part of the 1960s and early 1970s" [33]. Or as Dieter von Jezierski put it, "After 1970 the slide rule was quickly superseded by the pocket calculator, and by 1975 the 'tool of the engineer', the 'favorite of millions', and the 'nightmare of many students' reached the end of its centuries-long usefulness." [15, page 19]

Individual slide rules, replaced by calculators, found their ways to trash bins, or to garages and thence to garage sales, or to swap meets or antique shops or later to internet auctions. The Slide Rule, which had long been a *tool* in daily use, became an *exhibit* in a museum or private collection.

While existing slide rules suffered such changes in status, the production of new slide rules largely ceased. After recounting developments leading up to the 1972 introduction of the HP-35 calculator, Guus Craenen wrote,"The reaction of the slide rule manufacturers was dramatic; within a few months almost all of them terminated production" [8, page 42]. This apparently applies in particular to Nestler, the subject of Craenen's article.

Dietzgen, which had been perhaps the second-largest U.S. supplier of slide rules, dropped them, possibly in 1972 [5], [13, page 159]. Dietzgen still survives today, albeit as a division of Nashua rather than an independent company. But its product line, although still oriented toward engineering and related fields, no longer includes any calculating instruments.

Figure 1. Front cover of the book by Khrenov and Vizirov.

Other major slide rule manufacturers had similar experiences, some going out of business, some being sold to other companies, and in either case ceasing slide rule

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production. On the corporate turmoil of Pickett, actually dating to the departure of John Pickett in 1967, see Bruce Reichelt [30]. On the leveraged buyout of K&E see [2], [3]. Some slide rule purveyors attempted to sell electronic calculators themselves, but to little avail [35], [4, pages 28-29].

Frederick Post Co., which had been distributing Hemmi rules, was sold to Teledyne [27]. Paul Ross and Ted Hume state that Teledyne-Post ceased selling slide rules in the mid-1970s, but also that the last Versalog of which they know bears a 1972 date code [32, pages 37, 39]. In the Hemmi catalog compiled by Ross [31], there is a reference to "end of production in 1975" (page 42), although among the estimated availability dates for particular rules the latest specific year I find is 1974.

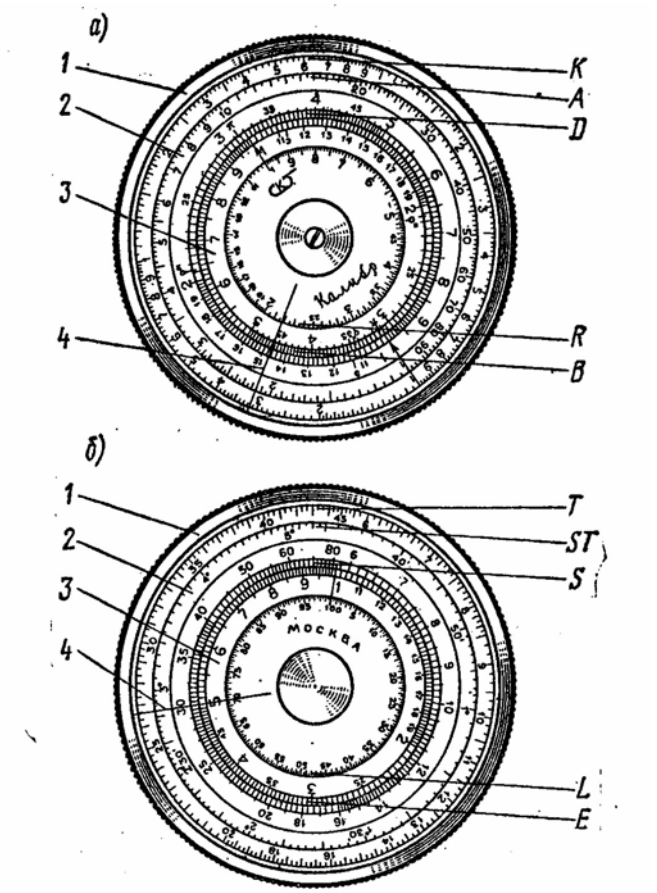


Рис. 17. Диск круговой логарифмической линейки «Спутник»:
а — лицевая сторона; *б* — обратная сторона

Figure 2. Khrenov and Vizirov Figure 17, depicting Sputnik circular rule.

Faber-Castell slide rules had similar timing, being produced until 1974, or perhaps 1975 [37], [36, page 2], [16].

Aristo persisted longer than others, but according to Hans Dennert [9, page 6] discontinued slide rule production and liquidated that part of the company in 1978, continuing its computer aided design business in a new company, Aristo Graphic Systeme. The firm's Bavarian factory in Gartenberg had already been shut down in 1976, according to Irene Dennert [10].

The collapse of the market for newly manufactured slide rules was not quite complete. Several manufacturers have continued to make certain types of slide rules or slide charts, primarily as either advertising items or calculating devices for specialty markets such as circular E6B flight calculators for pilots.

Among them are: Aero Products Research (310-641-7242); Allegheny Plastics (www.allegheny.com); Concise [14, page 97]; and Perrygraf (www.perrygraf.com). Tom Wyman [38] discusses some of these, plus several additional companies that produced, and in some cases still produce slide chart calculators.

Typically those items still manufactured are of sheet plastic or cardboard, although some from Concise are of molded plastic, and some from APR are of aluminum. However, the high-end general-purpose slide rules, such as leather-cased laminated mahogany log-log decimal trig duplex models, were banished from engineering supply shops and college bookstores some three decades ago.

When a specific date is cited for the end of the slide rule era, it is apt to be either 1972, or else 1975 or 1976.

The year 1972 marks Hewlett Packard's introduction of the first pocketable scientific calculator at $395. As Otto van Poelje put it, "The success of the HP 35 was overwhelming, due to its compact dimensions, flashy design, and extensive functions, and this very machine made the general public aware that the slide rule indeed was rendered obsolete by this successor" [29, page 51]. As mentioned above, 1972 has also been suggested as possibly the last year Dietzgen sold slide rules.

The year 1975 or 1976 refers to the largest of the U.S. suppliers, Keuffel and Esser, producing its last slide rule and donating it to the Smithsonian Institution. See Clark McCoy's website [24]; also see Hopp [13, page 192].

This received chronology is not just about the United States, even though the specific events of 1972 and 1975/1976 occurred therein. Of the three quotations with which we began, only one was from a US author; Schuitema and Jezierski are Europeans. Schuitema, for example, explicitly used the expression 'world-wide' in posing the question: "[W]hat was the reaction, world-wide, to the introduction into the marketplace of the pocket calculator?" [34, page 3]. And the aforementioned companies, if not fully blanketing the world, were at least spread around the world: Japan (Hemmi); Germany (Aristo, Faber-Castell, Nestler); and even Mexico (Pickett, briefly); as well as the United States.

This author's personal experience was consistent with that chronology. The $395 price of the HP 35 placed it far beyond my budget. A good slide rule could be had for under $30 at the time—and, anyhow, I already owned one. But that price advantage gave the slide rule only a brief respite. It was in 1974 that Rockwell broke the $100

price barrier for a handheld scientific electronic calculator. My Dietzgen 1734 went into retirement, and along with it my 'Magic Brain' rack-type pocket adder, and my CRC handbook of mathematical tables [12].

Not long ago I concurred in print with the received chronology, when writing that the 1973 book by Neville Young [39] "must have been one of the very last written not for historians, curators, and collectors of slide rules, but rather for actual slide rule *users"* [25, page 28].

A recently acquired book, however, suggests a significantly later date for the end of the slide rule era, and raises questions about the final production and distribution of slide rules manufactured by Keuffel and Esser or based on their designs.

The Khrenov and Vizirov Slide Rule Book

A Russian-language book entitled Логарифмическая Линейка *(Logarithmic Rule)* [21], was published in Moscow in the year 1984 but acquired by me only recently. See Figure 1.

The authors are Л. С. Хренов and Ю. В. Визиров. The first author, Leonid Khrenov, is a figure of some importance both in Russia and internationally, with a number of books at Nauka, the main Soviet science publisher, and some translated into English. The University of California library system has more than a dozen works by Khrenov, according to its Melvyl catalog; for a partial list see [17] through [20]. He edited several volumes of mathematical tables—including trigonometry tables, an edition of Barlow's tables, and tables for computing elevations in topographic leveling. He is also coauthor of a 1957 book on calculators and a 1989 book on the history of the development of the calendar.[2] Regarding the second author, Ilya Vizirov, I have no further information.

МОСКВА «ВЫСШАЯ ШКОЛА» 1984

Figure 3. Imprint, with 1984 date, from title page of Khrenov and Vizirov book.

This book may be of considerable interest to those researching or collecting computational devices from the former Soviet Union, and also to those researching specific details about the end of the slide rule era—particularly its timing.

It will be useful to note contrasts with the one other Russian slide rule book I have, an earlier book by Д.Ю.Панов (Dmitrii Panov) [28], which apparently went through several printings (my copy is dated 1959)[3].

Cm/K,A[B,CI,C]D,L and [S,ST,T] would be the English-language designation of the scale arrangement for the rules to which most or all of this Panov book pertains. (Russian scales typically are unlabeled; and the labeled ones sometimes use a mixture of Cyrillic and Roman alphabets. Herein I designate scales with their conventional western letters, which may differ from the labels, if any, in the book or on the rules themselves.)

These are the same as the scales on the rules discussed by Colin Barnes [6]. With my very limited knowledge of the Russian language supplementing my study of the diagrams whose 'language' is more universal, I find no indication of log-log scales, hyperbolic trig scales, or other specialized scales in this Panov book. Nor does it describe any circular rules.

The Khrenov and Vizirov book, at 96 pages, is shorter than the 128-page Panov book. But it manages to cover more different slide rules and more types of scales.

The book's coverage of rules from the former USSR is not exhaustive. For example, it does not include a simplex log-log rule from Kiev that I have in my collection, whose scales are Cm/K,A[B,CI,C]D,LL1|LL2 and [S,ST,T], and whose cursor wraps around the lower edge so the hairline reaches the second log-log scale. Neither does it include the machinists' rule described by Dennis Maack [**?**], nor other specialized rules of which I am aware, such as an NL-8 for airplane pilots. Still, this book is considerably more inclusive than the Panov book.

Khrenov and Vizirov cover log-log scale computations in the context of a duplex rule they call the 'Leningrad' (page 39 ff.). No model number is specified, nor even the particular factory, although from other sources it appears that more than one factory in that city produced slide rules [6].

The illustrations of the Leningrad slide rule (not reproduced here) depict scales K,A[CF,CIF,CI,C]D,DI on the front side. The reverse side is illustrated with the scales L,LL1,DF[CF,CIF,CI,C]D,LL3,LL2. Note that both illustrations show the same scales on the slide. With my limited Russian language skills, I am unclear whether this rule lacks trigonometric scales, or the slide has been reversed so that its same face appears in both illustrations, although my guess would be the latter. If so, that matches one in my collection bearing the name Leningrad in script lettering, and the logo of п inside с, which I take as dually signifying the name of the factory, Calculating Instrument, and optionally, for those of nostalgic bent, the saint for whom the city had previously been named.[4]

[2]He may also have written a 1968 slide rule manual, but neither I nor the UC Library System have a copy.

[3]I have seen auction listings for others with the same cover and number of pages, but various dates. Khrenov and Vizirov cite it with a 1971 date [21, page 94]. My impression is that Russian slide rules are much more common than Russian slide rule books, most rules apparently coming with only brief instruction sheets or none at all.

[4]This is logo number 2 in Barnes' article, although he describes the letters C and п as of unknown significance. Since the fall of the Soviet Union, the city is once again named for Saint Peter.

Khrenov and Vizirov also cover two circular rules. One of them, from the Caliber factory of Moscow, was named Sputnik (Спутник), which I understand to be the generic Russian word for 'satellite' as well as the name of a particular satellite whose launching was a key event in the 'space race'.

The Sputnik rule (page 52 ff., and Figure 2 herein) appears from the illustrations to have two disks, with one cursor on each side or possibly a single cursor that wraps around to both sides. The front scales, from outside in, are: [K,A,D][C,CI], although the CI is actually labeled 'R' and the C is mislabeled 'B' in the diagram. On the reverse, the scales are [T,ST,S,C,L], although the C scale here is actually labeled 'E'.

The second circular rule covered is the pocket-watch-type KL-1, pages 67 ff. (A KL-2 model, of which I have seen no instances, is also briefly mentioned, without illustration; page 79 ff.)

The Khrenov and Vizirov book's coverage is not limited to rules from Russia: also included is a Logarex rule from Czechoslovakia. Furthermore, there are rules from the other side of the 'iron curtain', including Reiss and Kastell, both from West Germany. Omitted, however, was another West German rule, the Nestler Elektro that was the favorite of the Sputnik satellite design team head, Sergei Pavlovich Korolev [26].

The Logarex rule is model 27403-II, a Darmstadt type, with scales Cm/L,P,K,A[B,CI,C]D,S,T,ST and log-log scales on the reverse of the slide (page 45 ff.)

The Kastell rule (page 36 ff.) lacks the Pythagorean scale, and may not be log-log. Its illustration shows scale arrangement Cm/L,K,A[B,CI,C]D,S,ST,T; the reverse of its slide is not shown, nor is its model number.

Two of the rules, the Kastell and the Reiss (page 37 ff.), are pocket-sized. The latter, model number 3212, has the Cm/K,A[B,CI, C]D,L scale arrangement. Its reverse is not shown, and apparently has no scales [13, page 212].

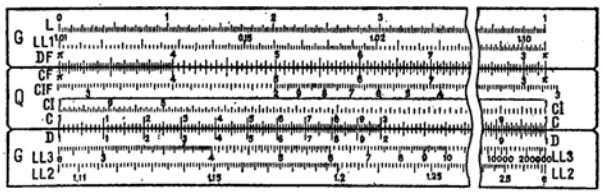


Рис. 15. Лицевая сторона корпуса и движка линейки «Кейфель и Эссер»

Figure 4. Khrenov and Vizirov Figure 15, depicting front of Keuffel and Esser rule.

Perhaps most striking, apart from the publication date of this book, is its coverage of a duplex rule with scales L,LL1,DF[CF,CIF,CI,C]D,LL3,LL2 and LL0,LL00,A[B,T,ST,S]D,DI,K, discussed on pages 51 ff., with illustrations of both sides, reproduced here as Figures 4 and 5. One of the same illustrations is repeated as a kind of wallpaper background for the front and rear covers of the book (compare Figures 1 and 4).

The name of this particular slide rule is Кейфель и Эссер – 'Keuffel and Esser' !

These diagrams for the Keuffel and Esser are schematic, not showing such details as a model number or the shapes of cursors and end plates. The scales are clearly visible, however. Trig scales are depicted in degrees and decimal fractions, so this would match a Keuffel and Esser 4081, at least as far as scale set and scale arrangement are concerned.

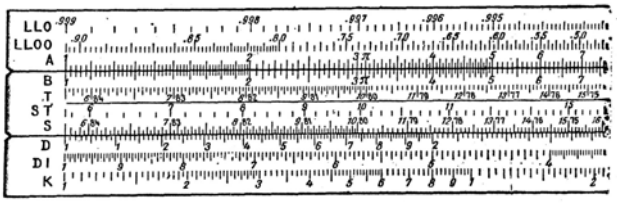


Рис. 16. Обратная сторона корпуса и движка линейки «Кейфель и Эссер»

Figure 5. Khrenov and Vizirov Figure 16, depicting reverse of Keuffel and Esser rule.

The publication date is unlikely to be a typographical error: it appears in at least three separate places, always as '1984'. See Figures 2 and 6. That is correct, 1984. This is a decade after the hand calculator had replaced the slide rule—at least according to the received chronology. Nevertheless, in 1984 the Russians were publishing new slide rule instructions for technical users such as engineers.

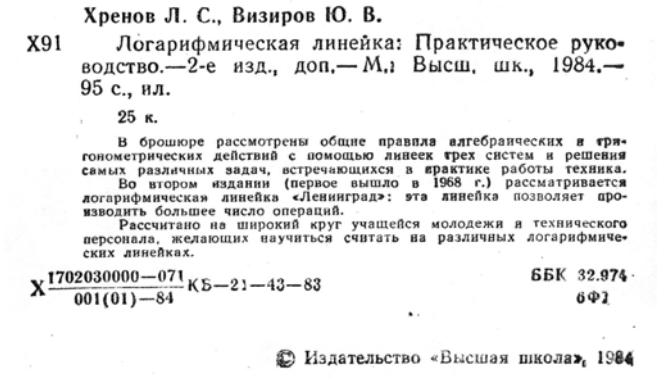
I should perhaps emphasize what kind of book this is *not*, as well as what kind of book it is. Clearly it is not intended for elementary school teachers and their pupils using slide rules as 'manipulatives' while learning arithmetic, as a Russian counterpart of the Pickett Elementary Simplex Math booklet [11]. Finding such a book with a late publication date would not be particularly surprising, and would not threaten prevailing ideas about when the slide rule era ended. But that is not the kind of book it is. Khrenov and Vizirov devote much attention to trigonometric and log-log types of problems, and barely mention addition and subtraction of distances.

Nor is it intended as a guide for historians, curators, or collectors of technical antiques, as a Russian counterpart of the Oughtred Society's own recently published *Reference Manual* [14]. A book aimed at that type of audience would surely have devoted some attention to early Russian contributions to the field, especially given that it appeared almost exactly 100 years after Cherepashinskii designed his rule, had it constructed, and wrote his instruction manual [7, pages 67, 132], [22]. A book of that sort might also have provided information on less well known contributors, including Fedotova [23] and Chelustkin [author's collection]. Khrenov and Visirov's

bibliography (page 94) includes nothing by Cherepashinskii, nor such other early Russian contributors as Berle, Bogustawski, nor Gasselblatt. Indeed, the entire bibliography (page 94) contains only 11 items, none of them older than 1952. No, that is not the kind of book this is.

Quite clearly the Khrenov and Vizirov book is a book of *instructions*. And the instructions are *not* about how to estimate a rule's value, nor about how to clean, polish, and display it. Rather they are about how to take non-integer roots and powers, solve trigonometric equations, and the like. Topic after topic is accompanied by worked-out examples and exercises for the reader. This book is a how-to guide for those who will do actual calculations in various technical fields – and who will do them on a slide rule.

All this as recently as 1984, and featuring a Keuffel and Esser rule to boot!



Хренов Л. С., Визиров Ю. В.

Х91 Логарифмическая линейка: Практическое руководство.—2-е изд., доп.— М.: Высш. шк., 1984.— 95 с., ил.

25 к.

В брошюре рассмотрены общие правила алгебраических и тригонометрических действий с помощью линеек трех систем и решения самых различных задач, встречающихся в практике работы техника.

Во втором издании (первое вышло в 1968 г.) рассматривается логарифмическая линейка «Ленинград»: эта линейка позволяет производить большее число операций.

Рассчитано на широкий круг учащейся молодежи и технического персонала, желающих научиться считать на различных логарифмических линейках.

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Figure 6. Bibliographic information and copyright notice, both dated 1984.

Discussion

Did the end of the slide rule era come a decade or more later than commonly thought, at least in parts of the world?

Did Keuffel and Esser sell surplus slide rules in the Soviet Union after the firm's U.S. market collapsed? Did it license designs to the Soviets on concluding it had no further use for them? Did some Soviets manufacture rules resembling Keuffel and Esser rules without bothering to license the name and design?

Was the decision to produce this book a publishing house error, a decision by some committee whose members had other goals in mind, or were actually unaware that demand for slide rules—and books about slide rules—no longer existed? Or did such demand in fact still exist? If the latter, was it only in Russia, or were there other places as well where The End was delayed to 1984 or beyond?

The situation here may be the sort of thing Dennis Maack had in mind when he wrote, "The fun of collecting is that there are always more questions than answers!" [23]. The same may be said of researching, as well as of collecting.

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Napierâ€™s invention was first published in 1614, though there is evidence that he privately communicated his work to a Danish astronomer, Tycho Brahe, in 1594.3 Napierâ€™s invention converted the operation of multiplication to addition and the operation of division to subtraction -- as long as you had a table of logarithms.Â The slide rule provided a mechanical way to do these calculations but there were some tricks the user had to learn. The slide rule only provides one cycle of logs-- or a single decade of numbers -- numbers from 1 to 10 say.Â The basic scales on a slide rule are the C and D scales. These scales have one cycle (1 to 10) of logs etched on them. These are used for multiplication and division.