Simple but effective

(once again about the Gruson device for multiplication and division)

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The device for multiplication and division proposed in 1790 by Johann Philipp Gruson is described in the article by Stephan Weiss [1].

Let us recall that the device was a disk divided into 9 sectors (see fig. 1). One of them was used for addition and subtraction of single-digit numbers, the others – for multiplication of numbers 2, 3, …, 9 by a single-digit factor. In each sector for multiplication, in addition to the products of the corresponding number n, the sums of these products with 1, 2, …, n – 1 were given (the added values are indicated on the periphery of the sector). A fragment of the sector for multiplication of the number 7 is shown in fig. 2.

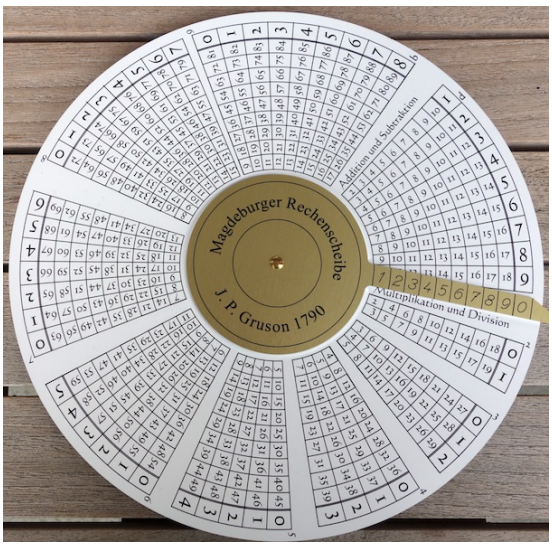

Fig. 1 [2]

Fig. 2 [2]

A ruler-indicator with numbers 1, 2, …, 9 rotated around the center of the disk. When the ruler was placed over a certain number, for example, over the number 44 in the sector for the number 7:

- the number on the ruler above it showed the integer part of the quotient from dividing 44 by 7 (6);
- the number under the ruler on the periphery of the sector is the remainder from such a division (2).
Of course, the question arises: "Why are the added numbers needed?" The answer is that they are used when dividing multi-digit numbers.

Let's look at the example of dividing 93457 by 7.
Since the divisor is 7, the sector of the device with this number was used (see fig. 2).
In this sector, the digit 9 (the first digit of the dividend) is in the first “column” and in the second “row” (with the number 2 on the periphery of the sector). This means that the first digit of the quotient is 1, and the remainder is 2. This remainder is taken into account together with the second digit of the dividend (2) – $2 \times 10 + 2 = 22$.
The number 22 in the sector is in the third “column” and in the first “row”, that is, the second digit of the quotient is 3, and the remainder is 1.
Similarly in other digits:
- $1 \times 10 + 3 = 13$. The next digit of the quotient is 1, remainder 6;
- $6 \times 10 + 5 = 65$. The next digit of the quotient is 9, remainder 2;
- $2 \times 10 + 7 = 27$. The next digit of the quotient is 3, remainder 6.

The overall result of the division – $13193\frac{6}{7}$.
When dividing by a multi-digit number using the described method, this operation was carried out separately for each digit of the divisor, after which all the resulting quotients were added together taking into account their weight.

Naturally, the device could also be used to multiply a multi-digit number by a single-digit number and a multi-digit number by a multi-digit number. For this purpose, all paired products of the digits of the factors were found on it, after which all partial products were added up taking into account their weight.

In conclusion, we note that the idea of using in the multiplication table not only the products of numbers n by 2, 3, …, 9, but also the sums of these products with numbers up to $n – 1$, was later used by Gruson in his book [3], which contains multiplication tables for numbers from 2 to 397. The use of such tables significantly accelerated calculations with multi-digit numbers.

References

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