Tens Carry only by Geometry – Josef Funke's Adding Device

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Sometimes calculating aids hide a mechanism no one ever thinks of. Recently I analyzed a single digit adder. In fig. 1 an addition is shown. For this photographs I used one of the items in my collection. It was manufactured shortly after World War II when they used coated zinc plate and therefore the finish looks bad. If the user wants to add 7 + 4 he puts the stylus into the hole next to the white 7 and pulls it down clockwise until the movement is stopped at the stop edge near the bottom. During this movement a small window moves down too and shows the fixed black unit digits from 0 to 7. Within this small window the red tens digit 0 runs down. If the user adds 4 the small window disappears under the cover plate and another one appears again under the upper edge, now, since 10 is reached and exceeded, with a red tens figure. This way one can add up to 309. The red digits on the right side of the white ones are used with subtraction. For me it looked like this small device can perform a discrete, a stepped, tens carry. With this strange behaviour my curiosity arose.

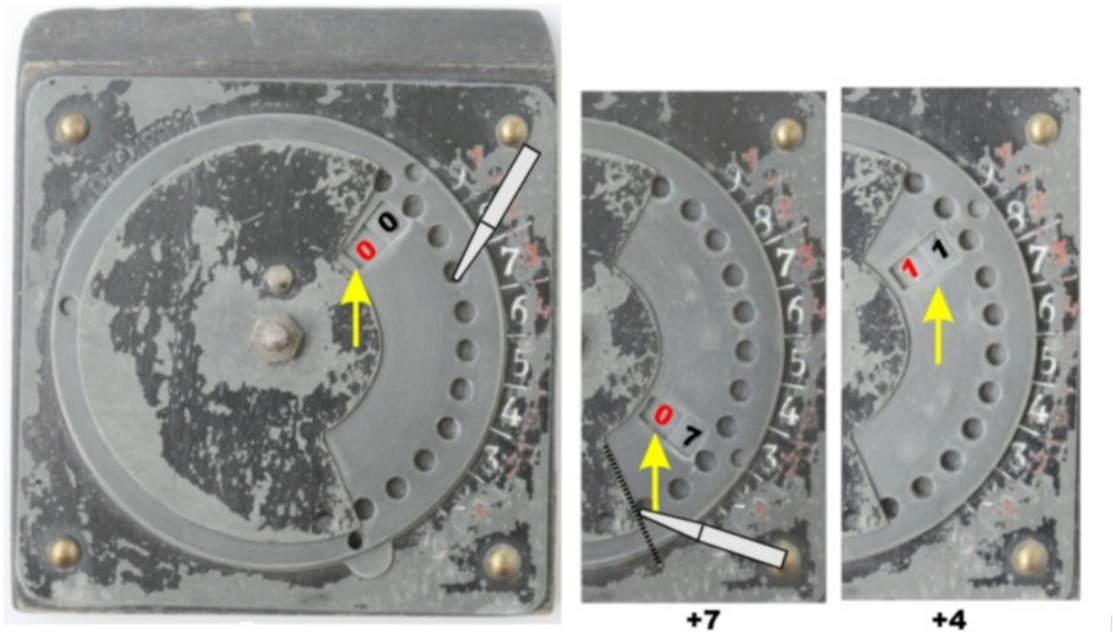

Fig. 1: Adding 7 and 4 with the device

So I dismantled the device and found, as shown in fig. 2 from bottom to top,
- a base plate,
- the tens disk with the red tens digits on it, rotating,
- the units disk, fixed,
- a wheel with three spy windows, rotating,
- a cover plate with a free 120° section, fixed, and, not to forget, on top
-a fastening nut.

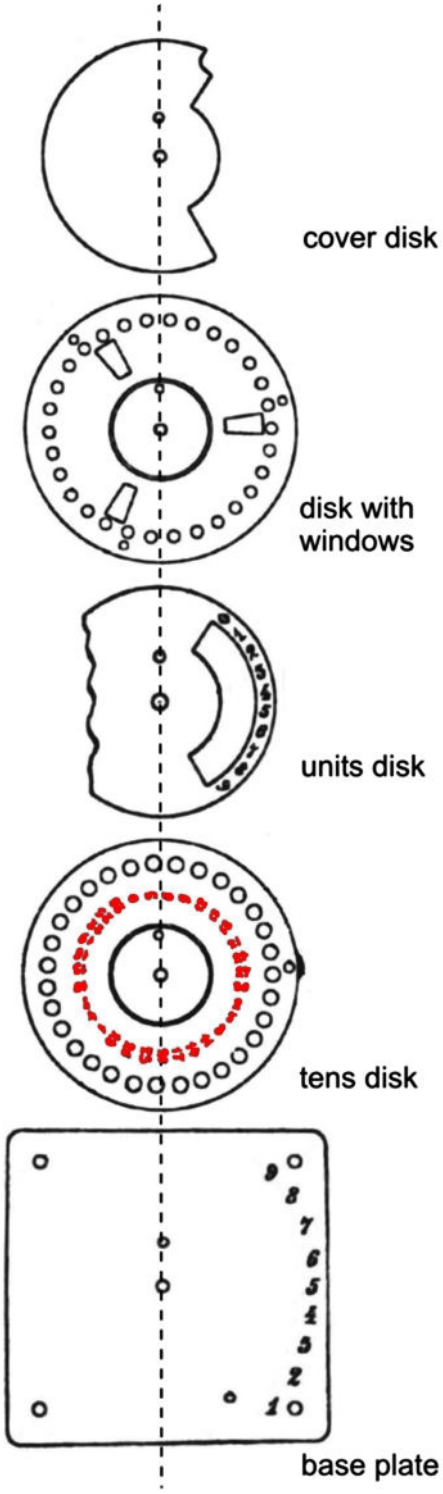

Fig. 2: Parts of the device

No toothed gear, no catch to be found. These parts only should perform a tens carry? I couldn't belive that. Next I hoped to find an answer in the patent claim of the German patent DE335921 from January 1920. It reads (in my very free translation)
“device to add single digit numbers with superposed turning disks with holes at their circumferences, the lower disk containing one hole more than the upper one... Thus while turning both disks the lower one... falls behind the upper one with each partial rotation. This way with figures on the lower rotating disk and on a fixed disk, both seen through openings, running sums during a single digit addition can be read.”

The patent claim in CH90984 (Switzerland) uses different phrases but says almost the same. No single word about the mechanism of tens carry itself. Up to then I didn't realize the different numbers of holes. I counted 31 holes in the tens disk and 30 in the disk with windows. From this geometric arrangement follows that, when the user pulls down the stylus, he actually moves two disks and consequently only at the stop edge the two holes on top disk and on bottom disk match in position. Should this be the key? Next I did some calculations. The divisions for the holes are 360° / 30 = 12° and 360° / 31 = 11,61°. The difference is 0.39°. A sketch, later improved and shown in fig. 3, helped by and by to clarify the question.

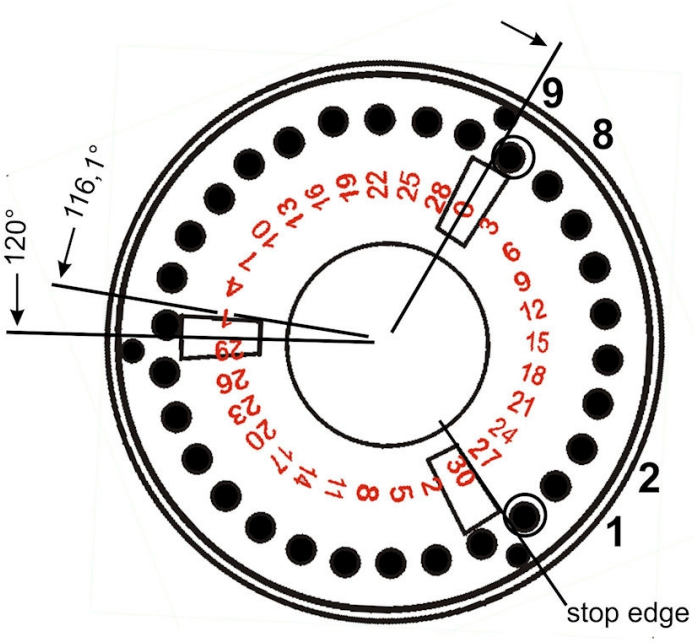

Fig. 3: The two disks with holes superposed.

The figure shows the tens disk with red figures on it and the disk with the three openings. The 30 holes there are shown filled. From the 31 holes in the tens disk only two are shown, one near the number 9 and the other one at the stop edge. The relative positions of both disks in fig. 3 are drawn precisely, because parts of this figure are based on photographs of the original parts. Furthermore the figure shows the division of 120° from opening to opening in the upper disk and the division of 116.1° (= 10 x 11.61°) from tens digit 0 to the next tens digit 1. The shown position equals the situation after having zeroed the device.
Going back anti-clockwise from the holes near the stop edge the positions of the next holes are displaced by 0.39° for digit 1, 0.78° (= 2 x 0.39°) for digit 2 and so on up to 3.51° (= 9 x 0.39°) for digit 9.
If we add 7 like in our example before, we put the stylus in there and move it down. First the disk with windows is turned by 7 x 0.39 = 2.73° until the stylus reaches the tens disk and from that moment on both disks are pulled down. Next we add 3 and the disk with windows is turned 1.17 ° more than the tens disk. With the whole displacement of 3.90° (2.73° from before and 1.17° now) the next small window is positioned over the next tens digit which will be 1 in fig. 3 and both appear on top of the free sector. If one repeatedly adds 1 up to 10 the whole displacement of 3.90° is the same, due to the small offsets of 0.39° from hole to hole. For the user the mechanism appears to run a discrete tens carry as I assumed first too, actually a continuous tens carry is performed. This effect can be watched best when the user only adds 1.
My experience: sometimes even in simple adders strange and interesting mechanisms are working like here a tens carry only by geometry.

Some words about inventor and history of the device: the inventor was Josef Funke (1884 – 1959), who lived in Germany. Probably before World War I he invented *Additionneur Funke Liége* shown in fig. 4. This device is made of painted cardboard. It has two separated disks, one for units and the other one for tens. It is unknown whether this version was really sold.

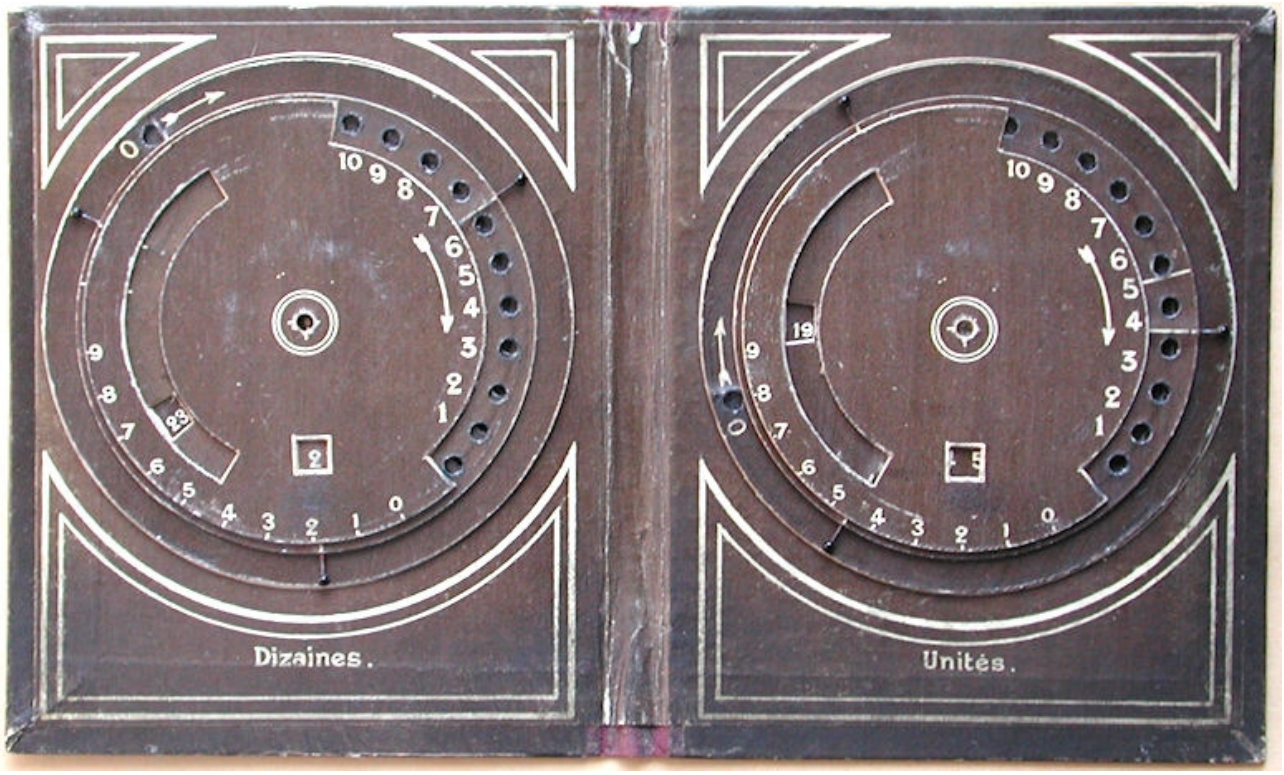

Fig. 4: Additionneur Funke Liége

In 1920 the two already mentioned patents were published: DE335921 and CH90984. In the Thirties Funke produced his adders in a small workshop in Munich and sold them together with a hand written instruction for use in the surroundings of Munich an in Upper Bavaria.
Also known is a chrome plated version of the device called *Himala,* used as a toy or educational tool for children (fig. 5).

Fig. 5: Version Himala

Fig. 6 shows an advertising paper in English language for the version called *Ada*. Unfortunately neither patent number nor location nor date are given. In this version several adders are mounted horizontally on a board to ease calcuations with multi digit numbers.

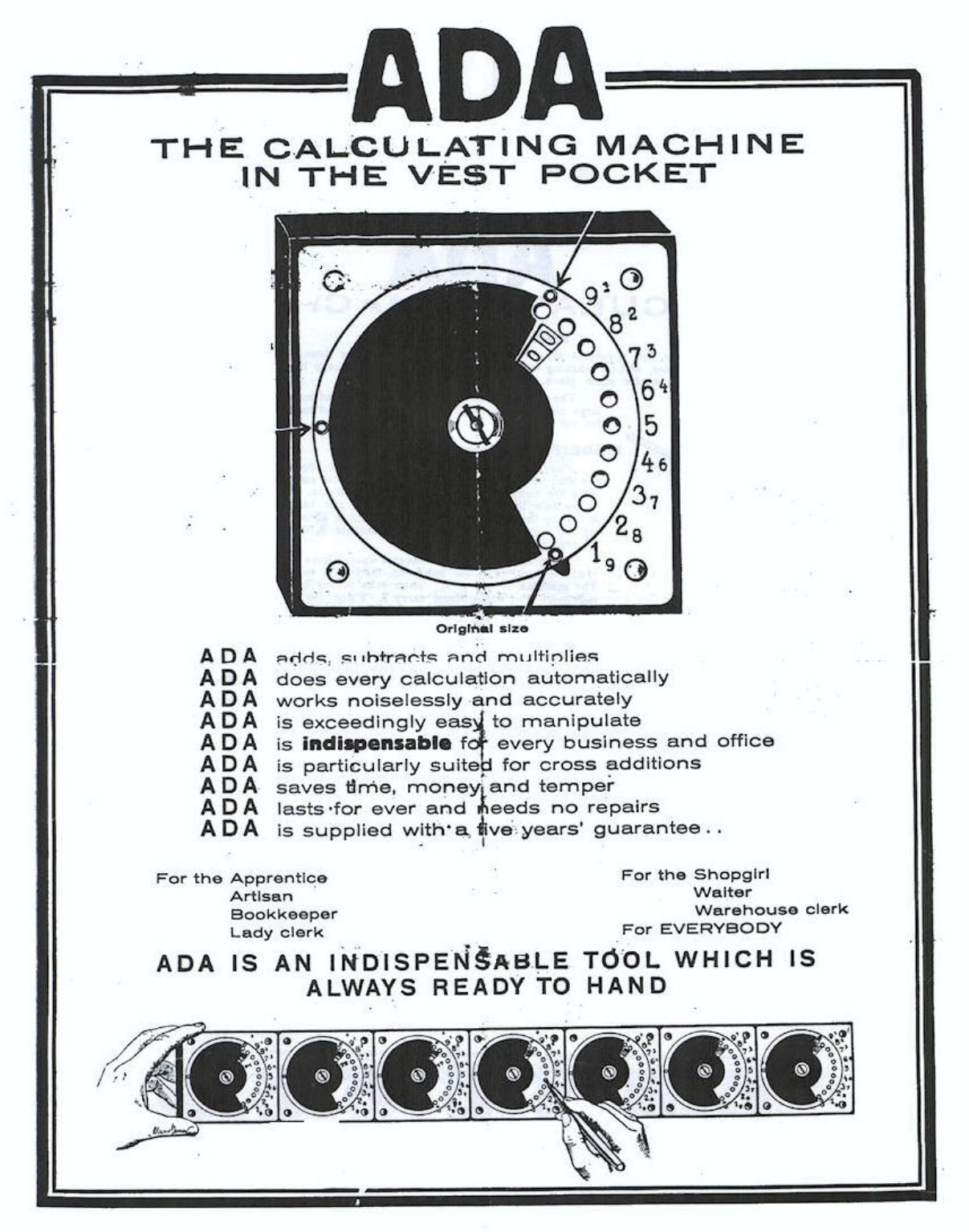

Fig. 6: Version Ada

Sources
Fig. 1, 3: crated by the author,
Fig. 2: based on a drawing in patent DE335921,
Fig. 4, 5: reproduced with kind permission from the owners,
Fig. 6: advertising paper.