Repairing a Burroughs Class 5 calculator

Francis Massen, Computarium
francis.massen@education.lu
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1. Introduction

Anne Baumann donated a Burroughs Class 5 key punched or key driven calculator from the 1925's (serial = 5-476549, **[Ref. 6]**). This machine was bought at a flea-market in Switzerland. It was in a very pleasing visual state, but completely blocked: nothing moved, neither crank nor number wheels.
The Burroughs is similar to the Comptometer, concerning the main mechanism common to all keypunched calculators:

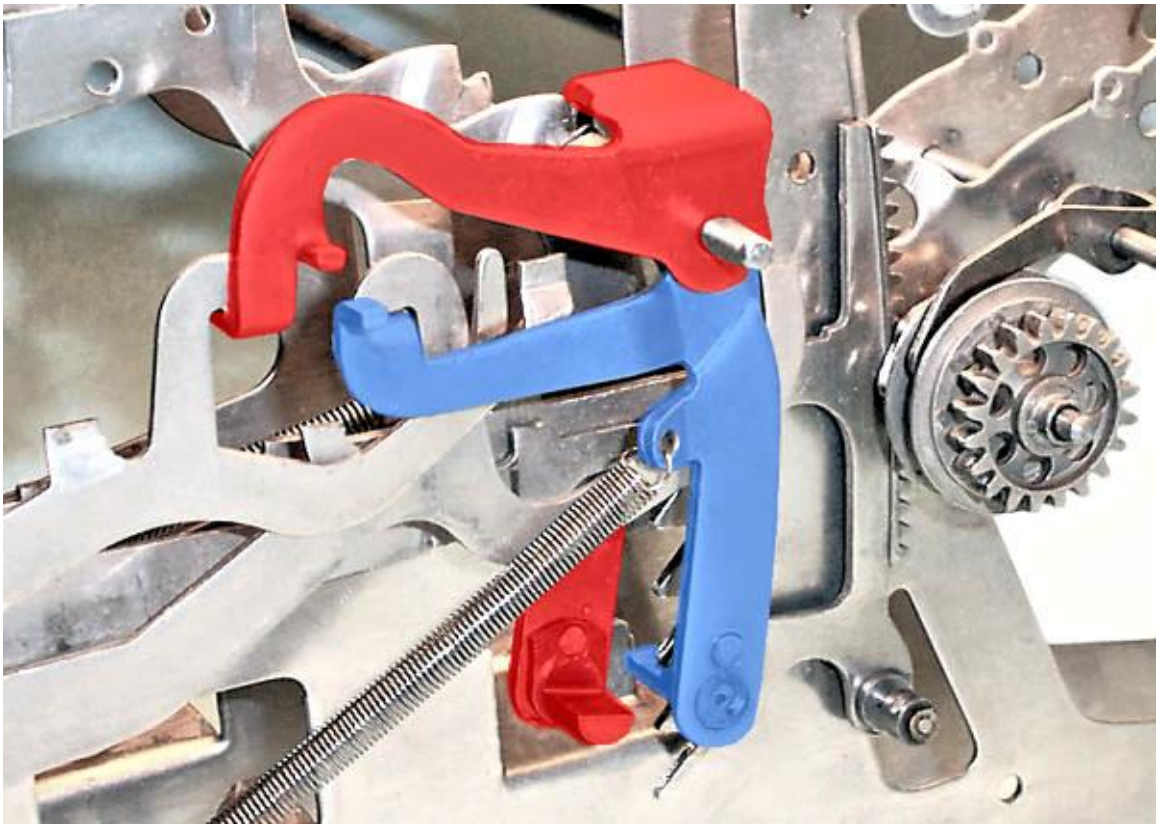

*Fig.1: This is the system on a Comptometer **[Ref.2]**: the toothed segment at the right moves down according to the key pressed and turns a toothed guiding wheel, which is freely rotating on its axis. When the key is released, a second part of that wheel now becomes fixed and transmits its rotation to another toothed wheel of the addition mecanism, turning that wheel by the number of theeth corresponding to the key pushed down (see later). [Comptometer, **Ref. 2**]*

The Brunsviga differs from the Comptometer family by a special complicated planetary system moving the number wheels and doing the carries from right to left.
John Wolff, certainly one of the best calculator restorers of the world, does not refrain to dismantle a complex calculator completely, cleaning and reassembling it **[Ref. 1]**. I had neither the courage nor the competence to do this, so I tried to bring back to life the machine by working on it without disassembly. This short lab report describes some parts of this work.

2. Information available on the internet

Curiously, with the exception of John Wolff's website **[Ref.1]** and that of Prof. Hamann **[Ref.3]**, not much information can be found on the internet regarding this Class 5 Burroughs machine. A video with the same Class 5 machine can be found here:

Fig.2. Youtube video (TheIDofED) of the same Class 5 Burroughs model (link).

The video shows attempts to unblock the machine, which does not seem to be badly stuck.
A second video by Joe van Cleave shows the operation of a 7 column model, with the authors complaining on the important work needed to restore it:

Fig.3. Joe van Cleave complains on the work needed to restore the calculator (link)

3. Starting the restoration

I knew nothing about these Burroughs machines, and not even what the position of the wheels should be in the zero position,

First the machine had to be opended: there are 2 screws at the rear and a lock at the front, which was closed, and I did not have a key. Prof. Hamann **[Ref.3**] shows how to make a new key, but I simply cut the tongue with a Dremel, which solved this problem, and I could remove the machine from its enclosure.
Looking at the videos, I was able to see that in the zero state all number wheels should be like in Fig. 4. (they were not!):
Fig. 5 shows the wheel system in more detail.

In our machine, everything was blocked, not a single wheel or part was moveable. This is no wonder, as the machine was resting probably for many decades, and all moving parts became stuck. John Wolff sent me a very nice picture showing in an "exploded" fashion how the wheels of a column engage around a supporting thick wire axis (Fig.6): the 3 wheels C, A and B (from left to right) must move on the axis, where they rest by their sleeves. All these contacts between sleeves and axis were frozen in our machine. The small riveted wheel which pivots on the left aluminum wheel also was completely blocked.

On top of that, all moving parts supported by another axis were also blocked (see Fig. 7 & 8). The spring below the left side number wheel works as follows: each increase of the number wheel moves the lower end of the spring down, which becomes more and more extended. The crank "Return to Zero" releases that spring under tension, which rotates back the number wheel to its zero position (Fig. 9)

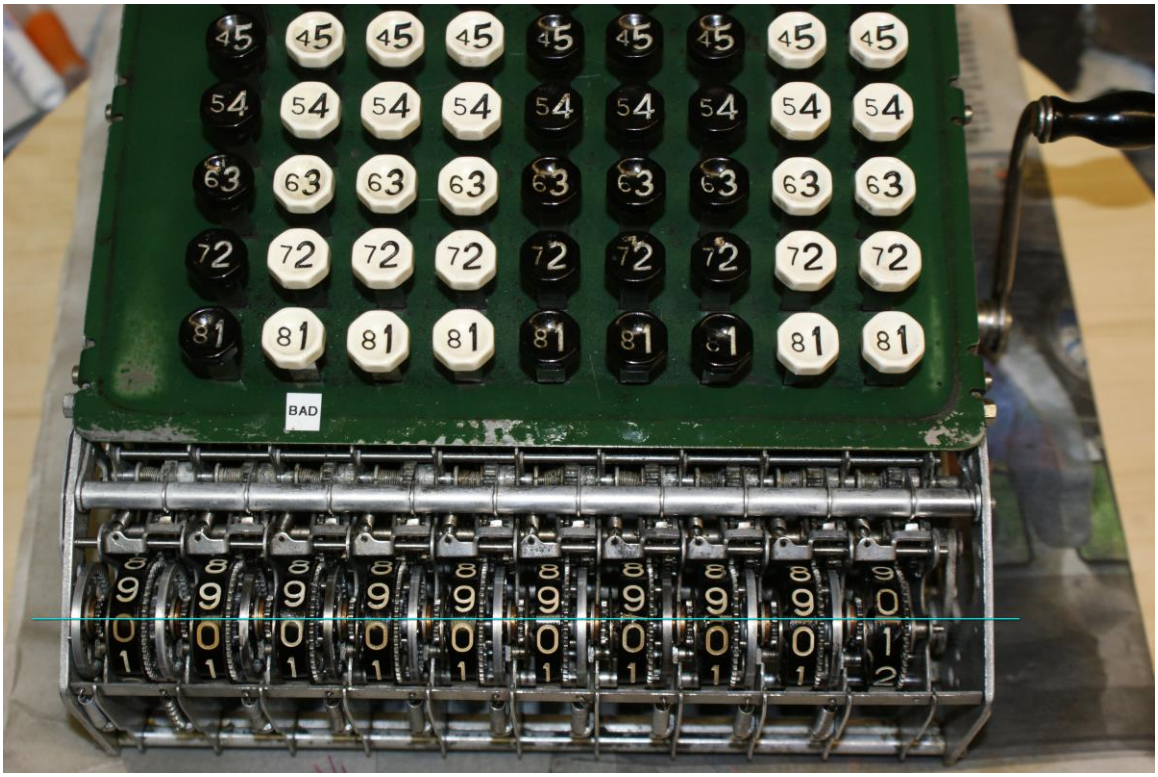

Fig.4. Zero position of the machine: look at the thin blue line (situation after repair).

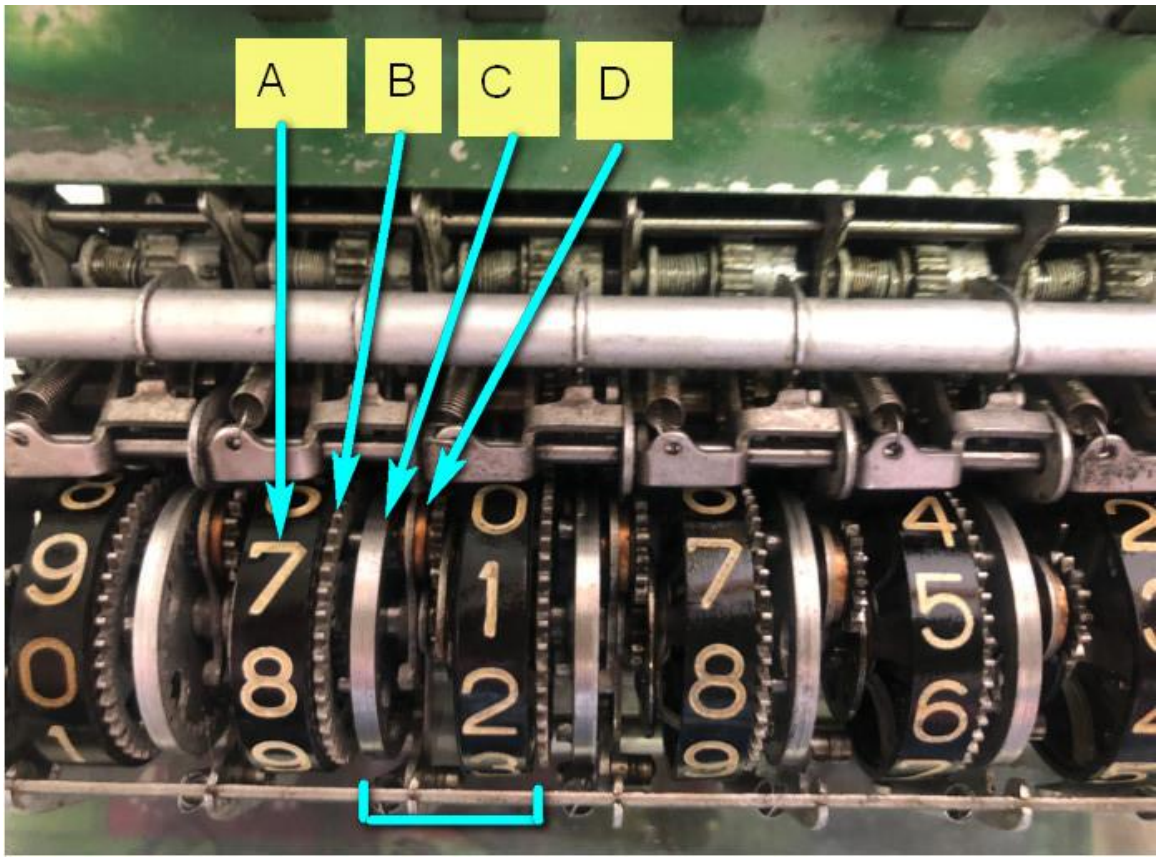

Fig.5. The blue bracket shows the system for one column: there are 3 larger wheels (A,B,C) and a smaller wheel (D) riveted to wheel C.

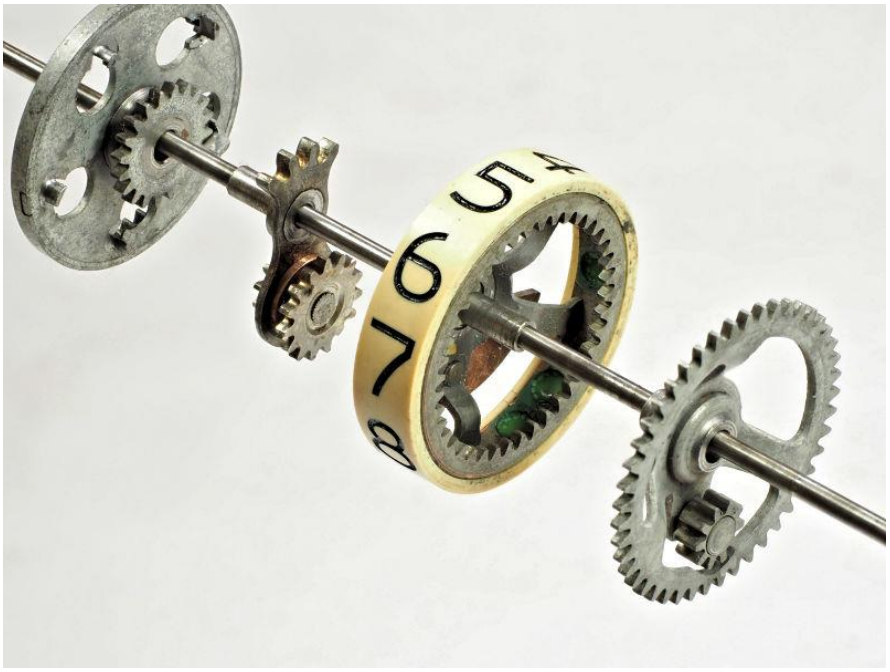

Fig.6. Planetary system of one column (photo by John Wolff, personal communication)

These were not the only blocked sleeves: another axis going through the machine supports the pivoting Return to Zero mechanism as well as filler sleeves, which were also blocked completely:

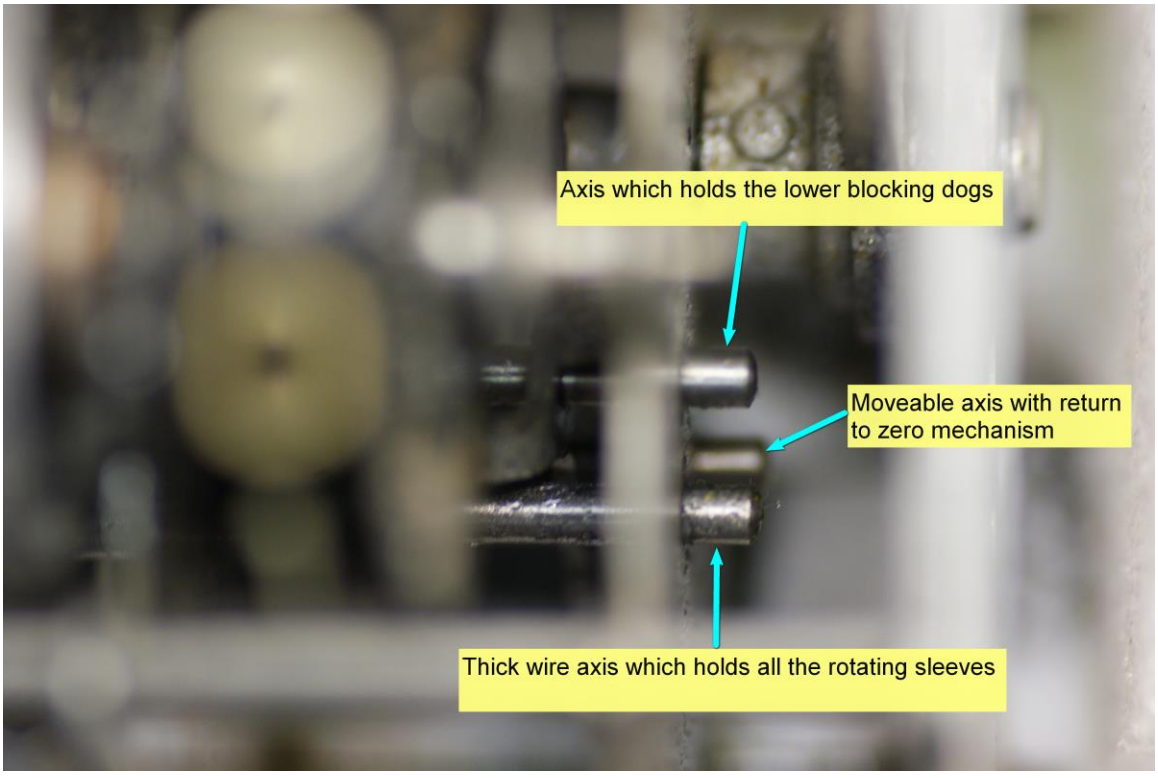

Fig. 7: The 3 main wire axis stubs seem at the right side of the machine

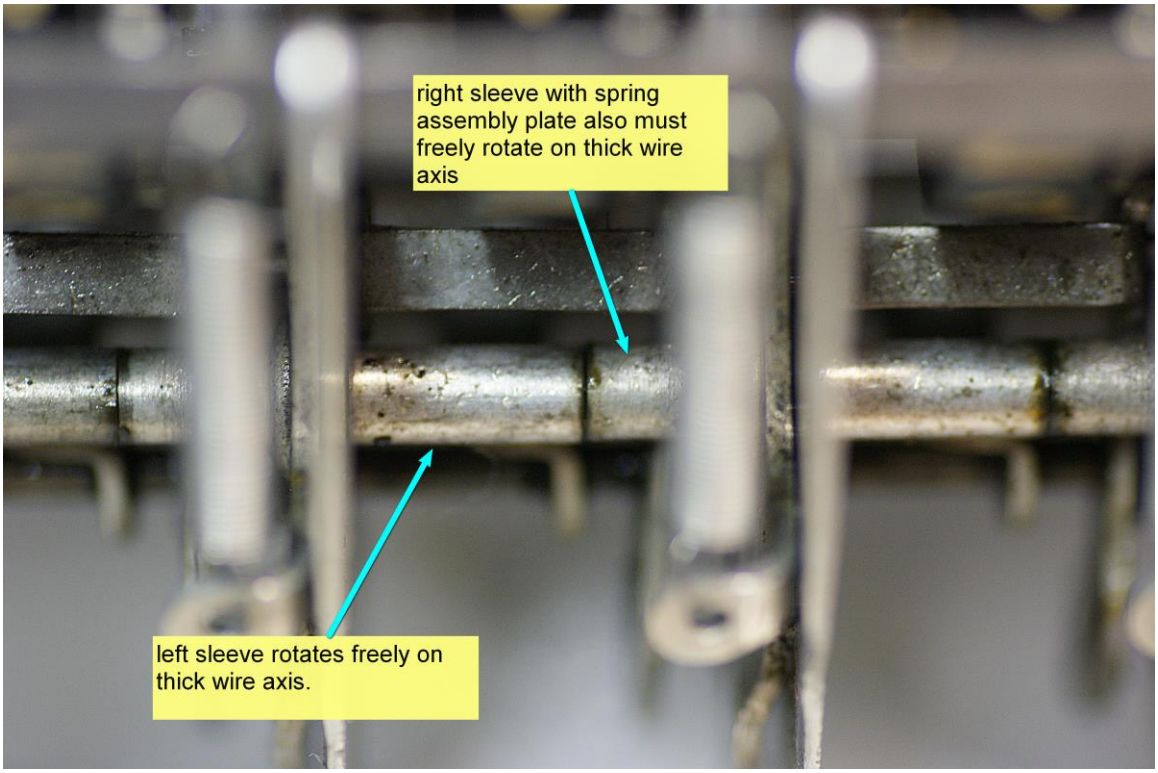

Fig. 8. Sleeves resting on the main axis, which were all blocked.

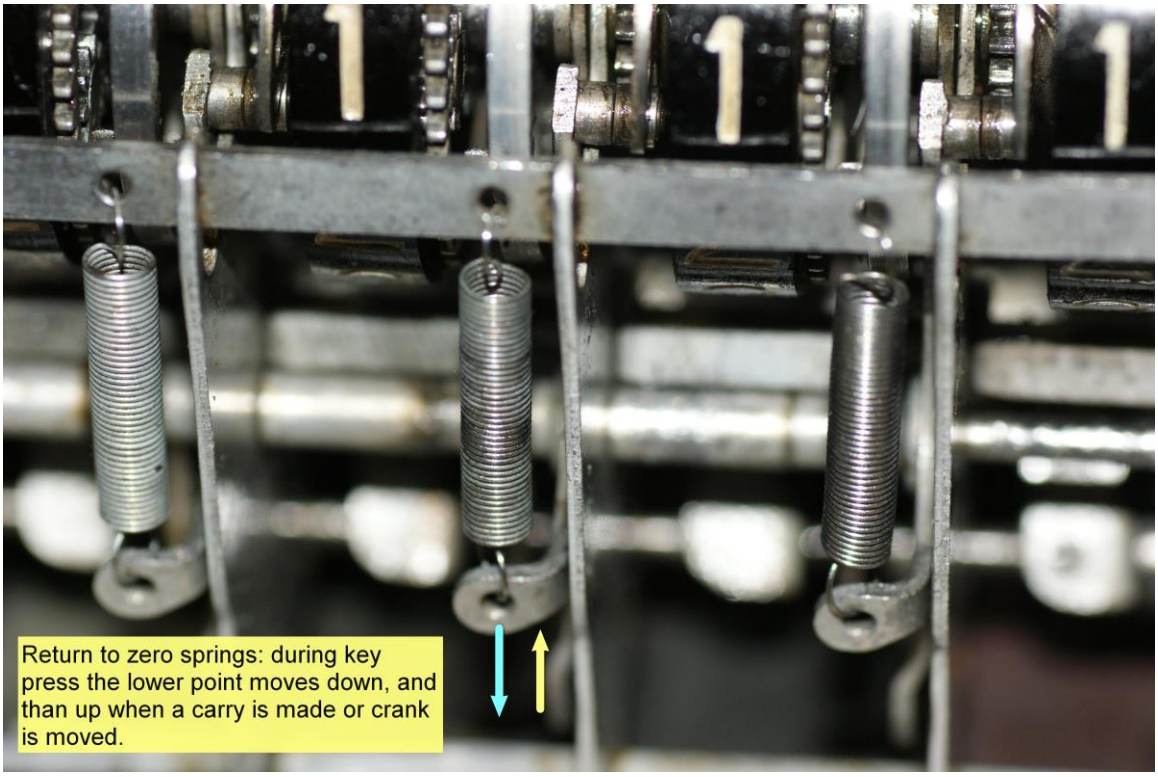

Fig. 9: Return to zero springs: typing a number moves the lower part down, which brings the spring to tension. Springs goes back when a carry is made or the crank makes the zeroin movement

To start the restoration, I used plenty of oil, not the infamous WD40 which gives a short lived satisfaction (and becomes sticky after 6 months), but a weapons-grade oil.

I first tried to move the number wheels with respect to their right narrow toothed wheel: holding the plastic wheel immobile, I carefully wiggled the narrow wheel slightly up and down, and this often took at least 20 minutes before both became loose.
There is an easy test to make: if one moves a number wheel slightly forwards and back, no other wheel should move: if it does, that means that the first grips to the axis instead of turning freely, and that the rotating axis moves another stuck wheel.

The crank does not work correctly (or not at all), if not all wheels are free to rotate. Now after some parts of that first steps were done, the crank became moveable a bit; next I tried to free the small riveted wheels, which were all stuck. Here again, the work is Benedictine, and you must not count the time.

Now the crank could be pulled down, and one or two wheels found their zero position. But the crank often was blocked after that, because it did not return to its correct initial position.

Luckily, a lever could be manually pushed to the rear to unblock the crank without exercising dangerous force:

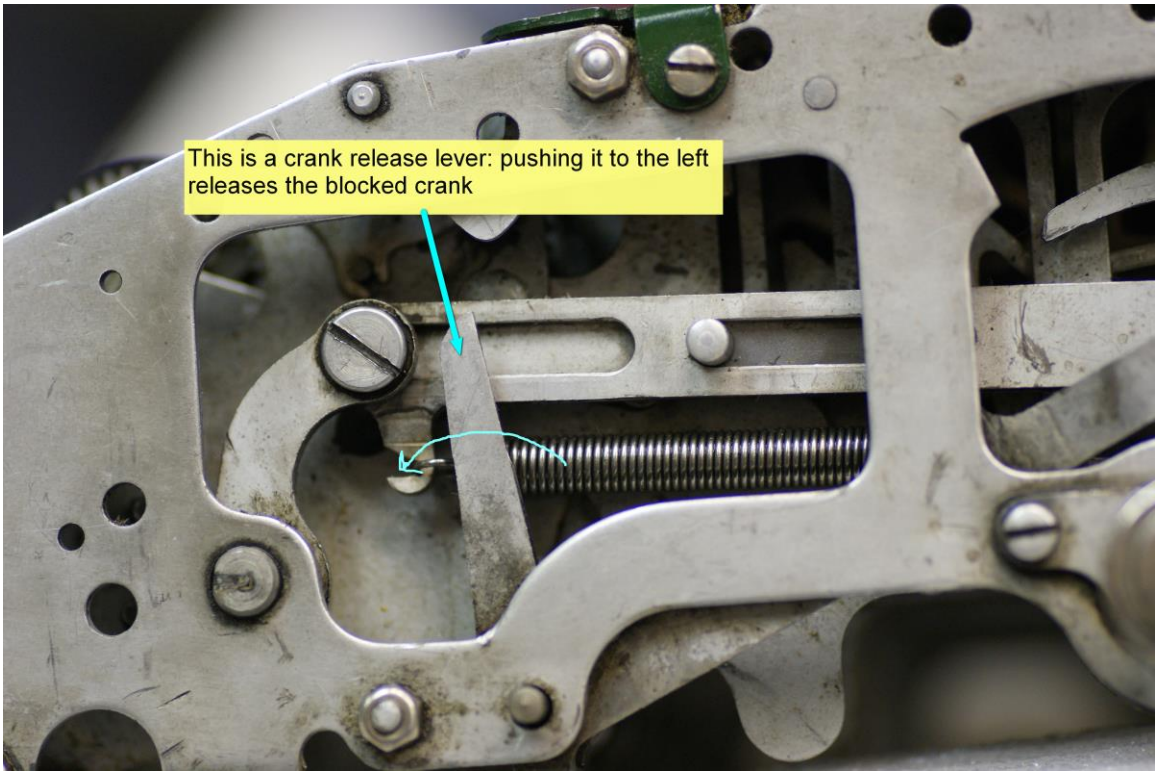

Fig.10: Lever to free blocked crank

Keys must not be pressed when the crank is moving: Fig.11 shows a lever at the rear right side, which rotates a special axis to block all key movements.

An important role is given to a row of toothed cylinders (see Fig.5, just below the edge of the green cover plate), which are hollowed out andd can freely turn or move laterally on their axis. In their normal position, these cylinders are at the right and transmit rotary movement to the number wheels. Fig.14 to 16 show this in detail.

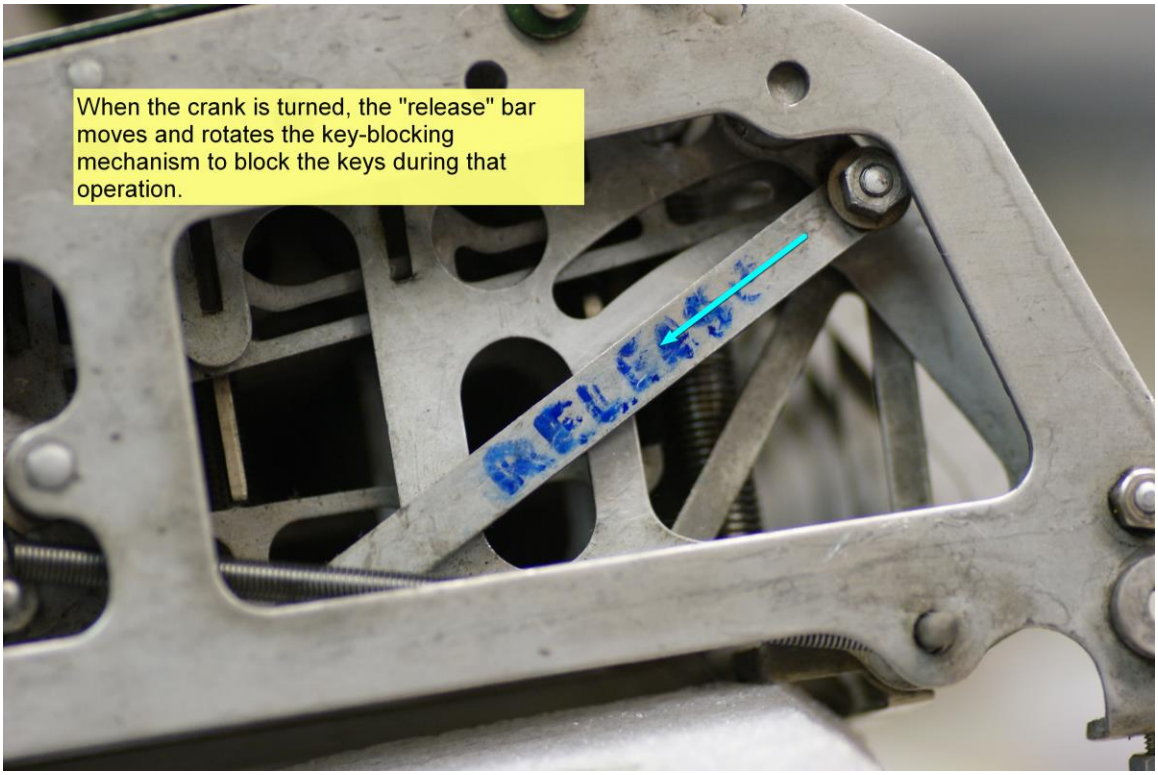

Fig.11: Lever pulled down in the direction of the blue arrow to rotate the key blocking axis

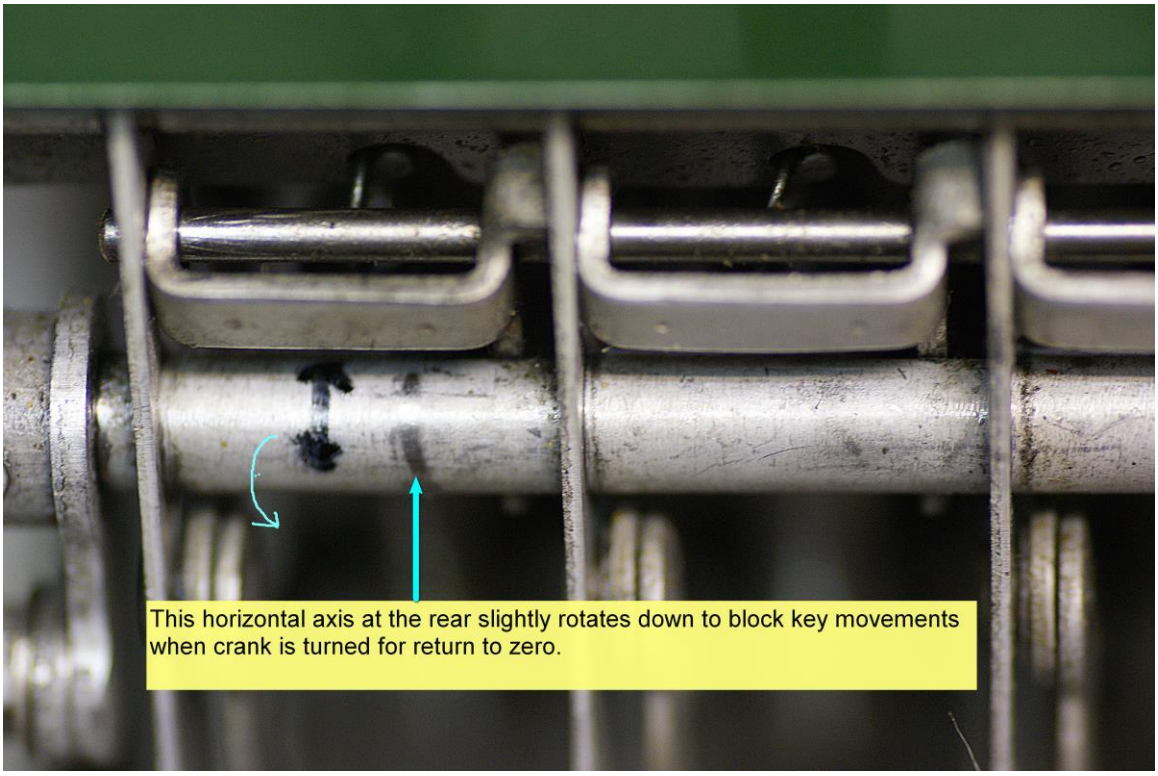

Fig.12: Key blocking axis at the rear. The cylinder has rectangular cut-outs (not visible here). In the normal position, the key stems slide along these cut-outs; when the crank moves, the cylinder very slightly turns, so that the cut-outs block the key stems.

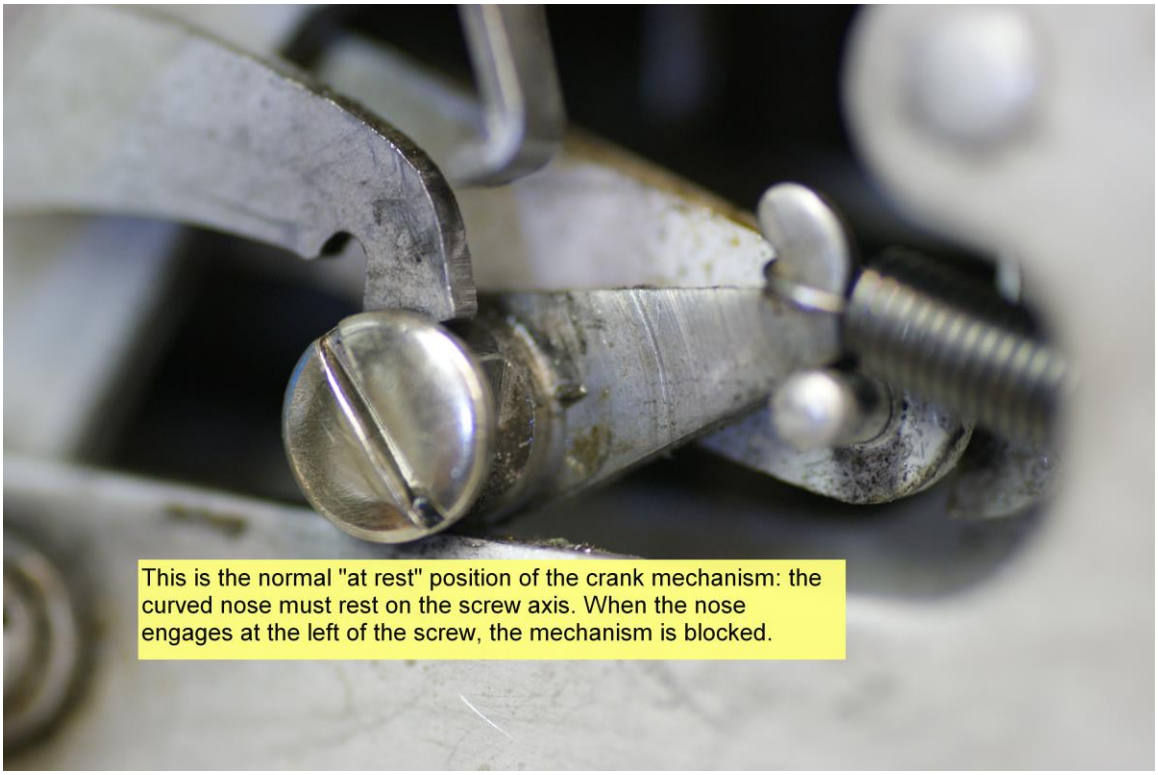

Fig.13: This is an important situation: the crank activated lever must rest on the screw as shown for normal operation. Sometimes this may not be the case!

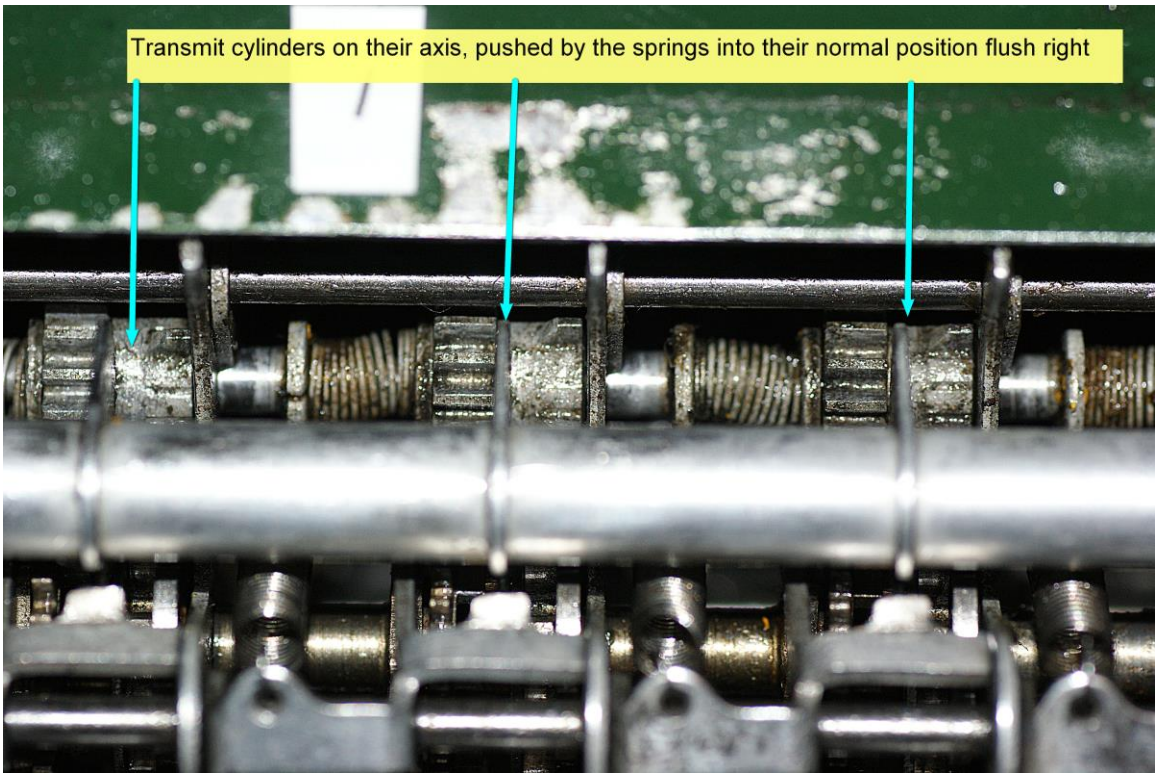

Fig.14: The transmit cylinders in their normal position

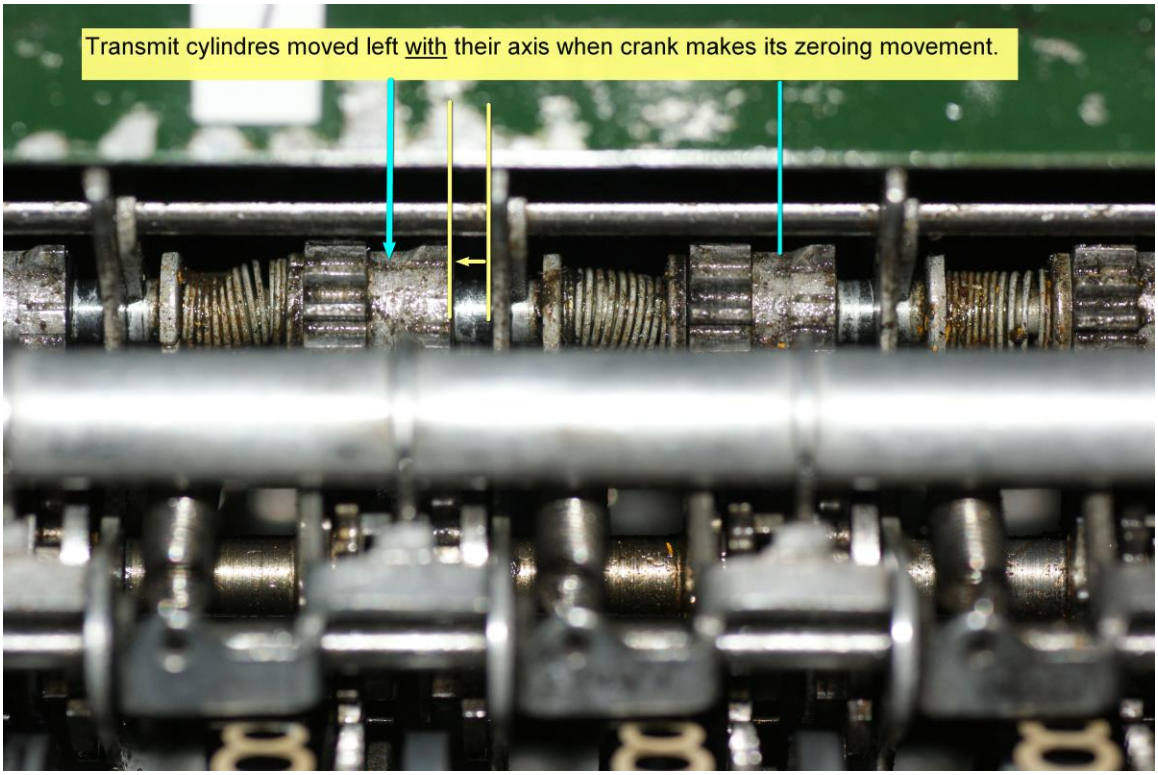

Fig.15: The transmit cylinders in their left position, disengaged from the number wheels. during the crank movement

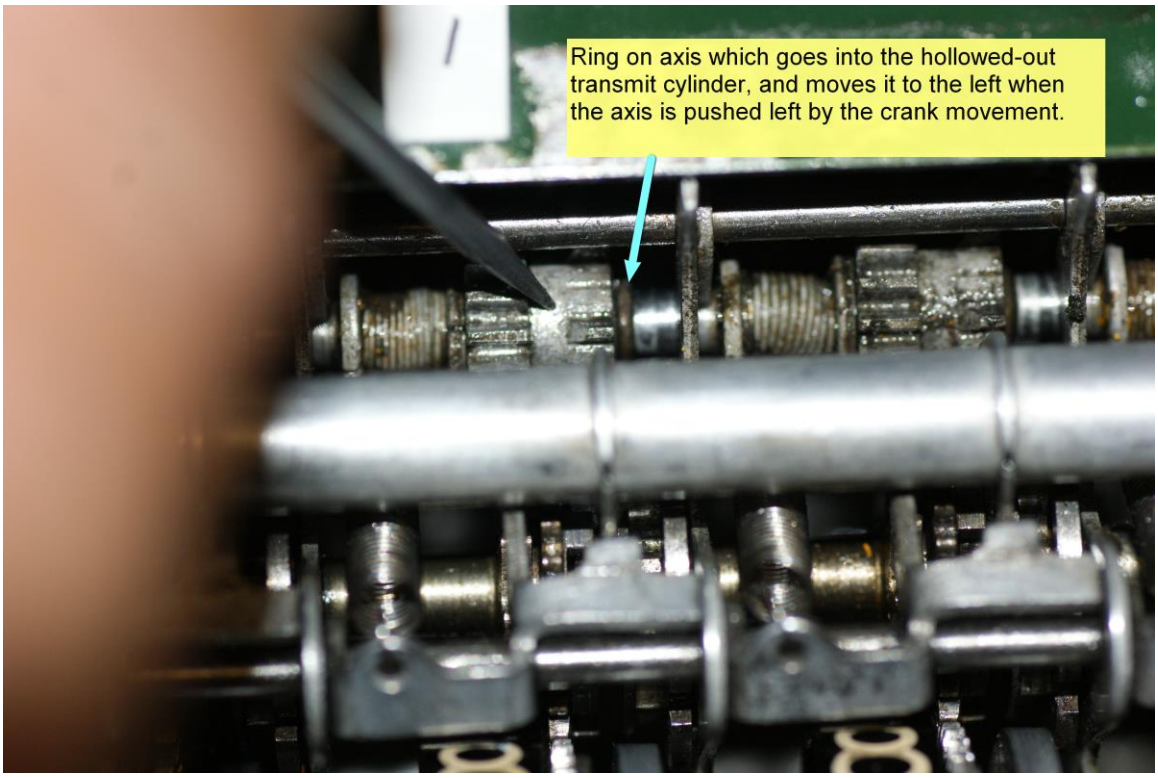

Fig.16: The ring on the moveable axis which pushes the transmit cylinders to the left. This ring is normally not visible.

A frequent problem with crank blocage I encountered was that a transmit cylinder did

not sit correctly on the ring. The rotational position of the transmit cylinder is **not** arbitrary in my opinion (column #6 for instance works only with one special position), and some positions may not go well in accepting the ring into the hollow-out (could be a problem of wear). So one has to try different orientations of the cylinder to find one which allows a correct and complete lateral movement and swallowing of the ring.

4. Bottom and rear

The movement of the bars with the toothed segments must be a nearly vertical movement in the Burroughs Class 5. Some key driven calculators do this differently: the segment first goes down when a key is pressed, than, when the key is released, moves to the front to engage and up to drive the wheels. In our machine, there is a somewhat complicated system to insure a close to horizontal movement. There are rear guides and a black metal assembly all making these movements possible.

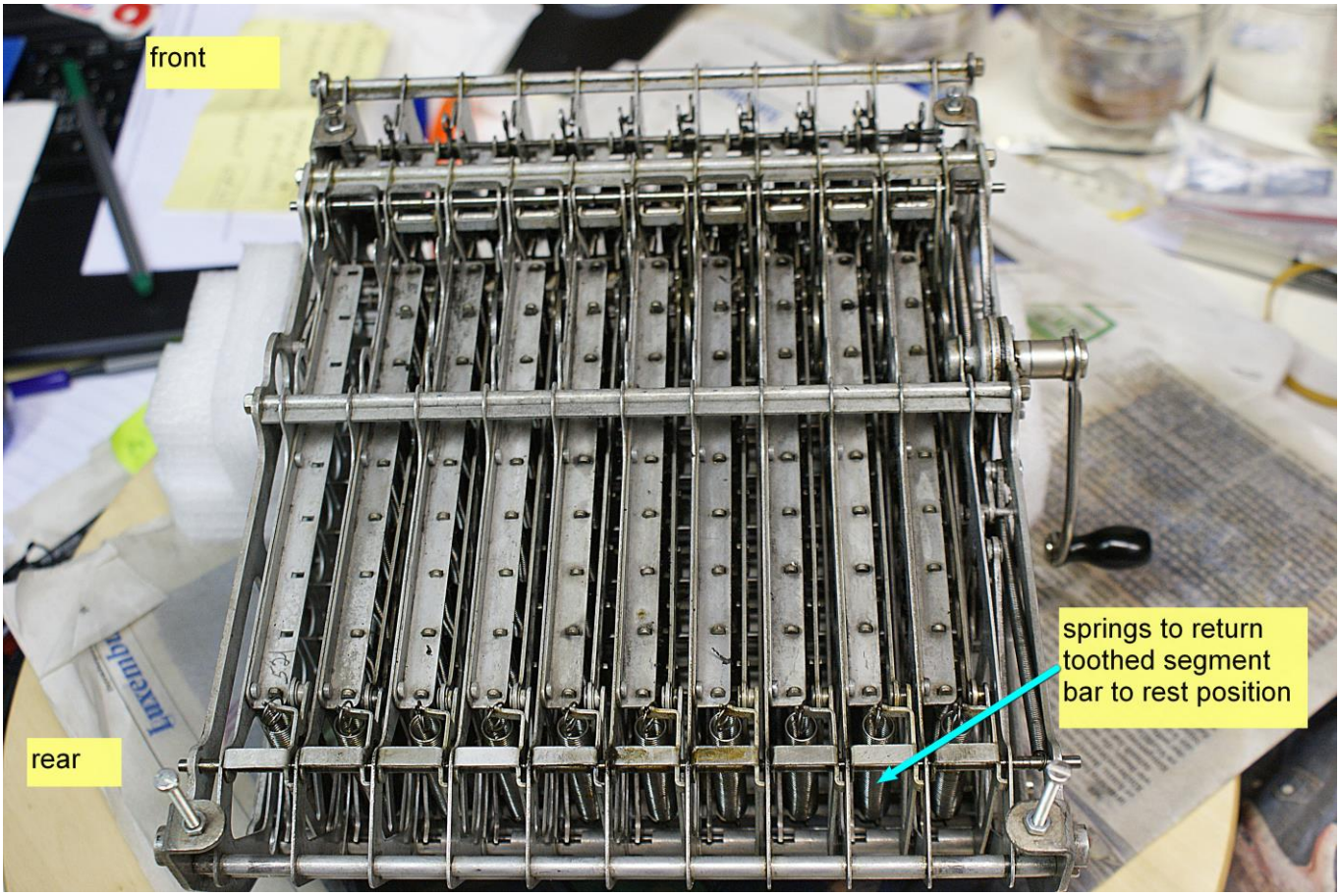

Fig.17: Calculator belly up; the arithmetic number wheels ar at the top of the picture.

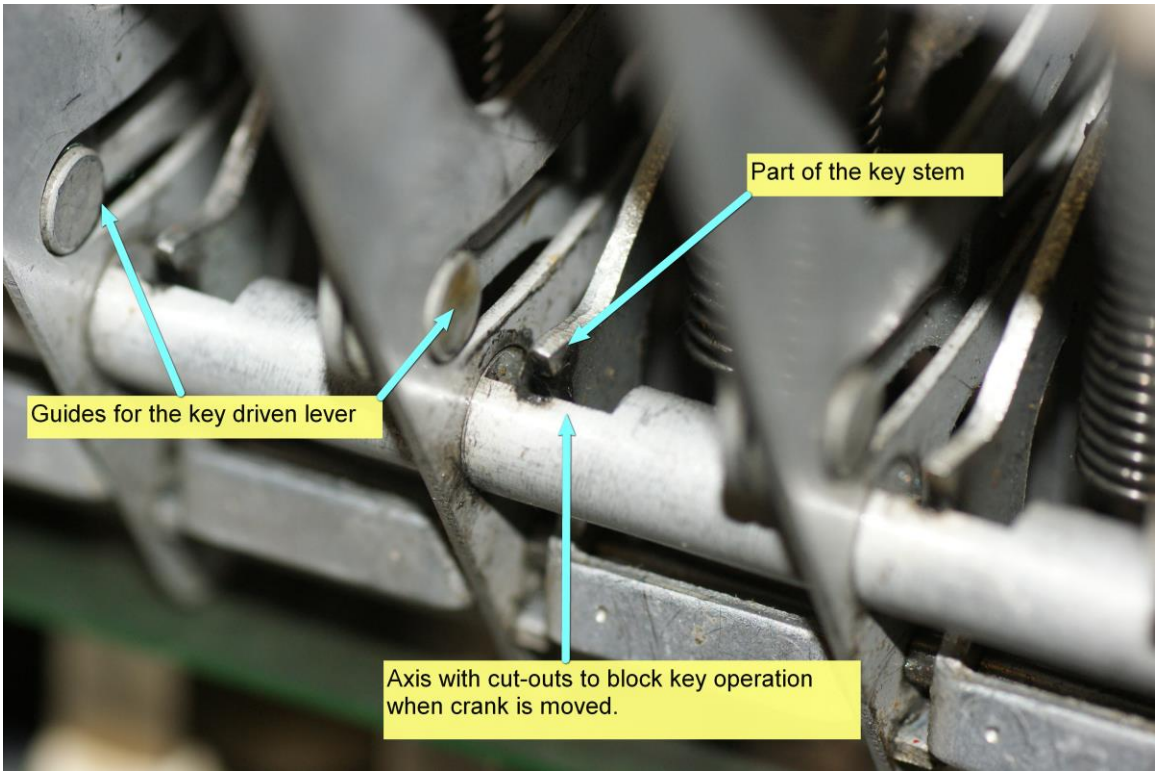

Fig.18:Close-up view showing the guides and the blocking axis with the cut outs (see also Fig.12)

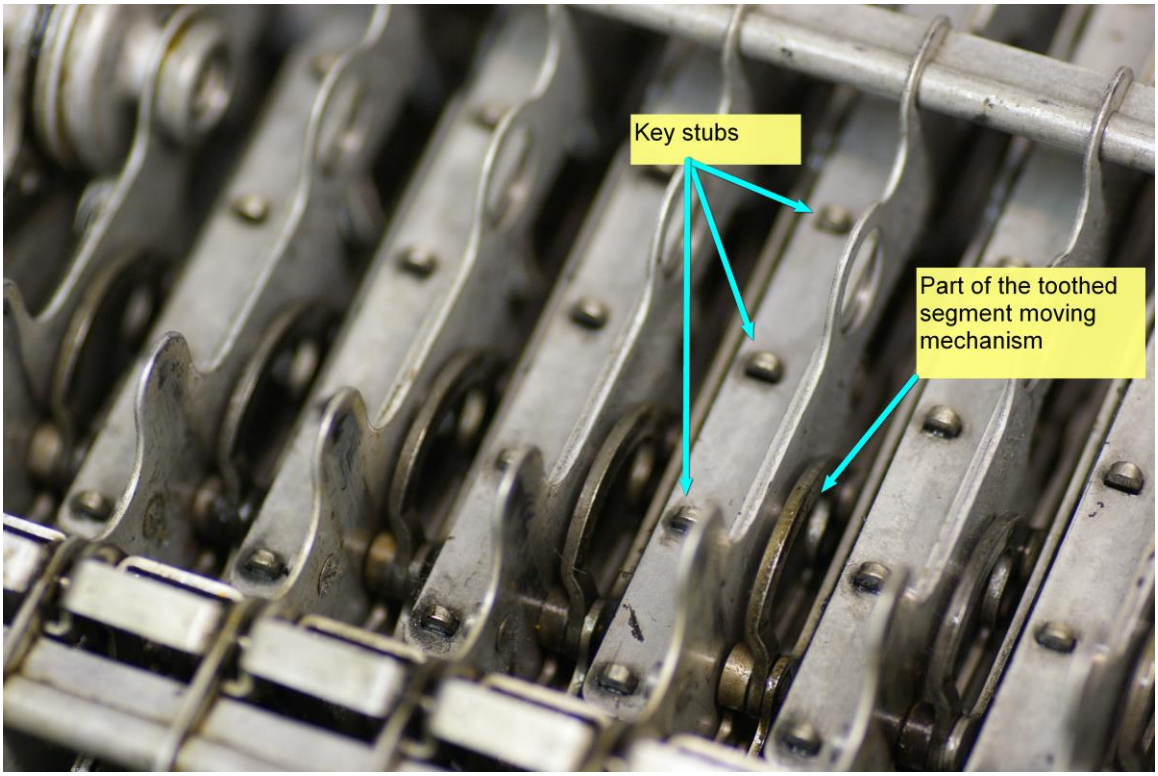

Fig.19: Close-up on the black metal guiding system and the protruding stems of the keys (none is pushed down).

At the front side, below the number wheels, the sliding axis which is moved down by the crank when making a zeroing can be seen:

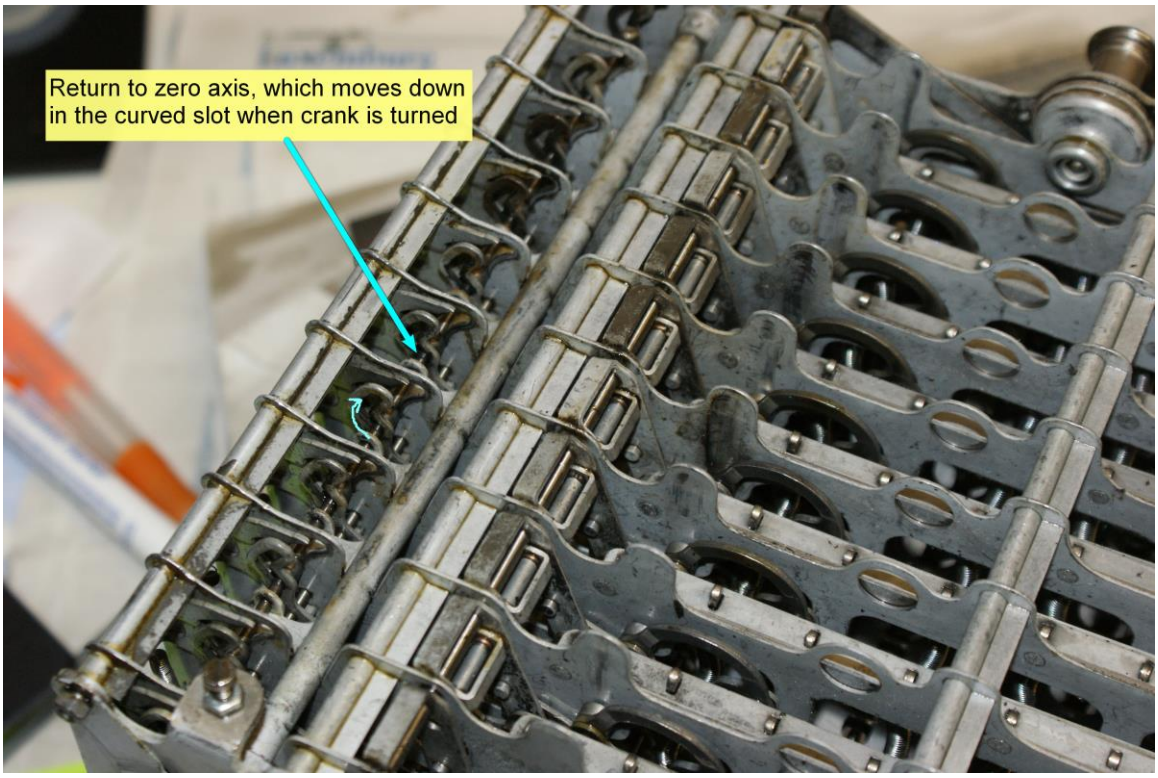

Fig. 20: Return to zero wire, on the front.

Finally, let us look at the double wheel mentioned in the legend of Fig.1. This part is very difficult to see properly and to photograph. Here in Fig. 21 the first right number wheel is shown.

A problem at nearly all columns was that these two parts were "glued" together, and did not rotate freely.

5. Conclusion

I was unable to make the second last column #8 work correctly. The problem is essentially that the double-wheel mentioned above does not rotate freely for this column: both parts stick together, and I am unable to put them free, without disassembling the whole machine. Nevertheless, the carry from column #7 works fine, as does the carry from #8 to #9.

From time to time, a key in column #6 does not release correctly, but usually that is due to an incomplete or hasty crank movement.

Compared to the state in which we received the machine, I think one can moderately be satisfied with the restoration. Figures 22 to 24 show the restored machine in its enclosure.

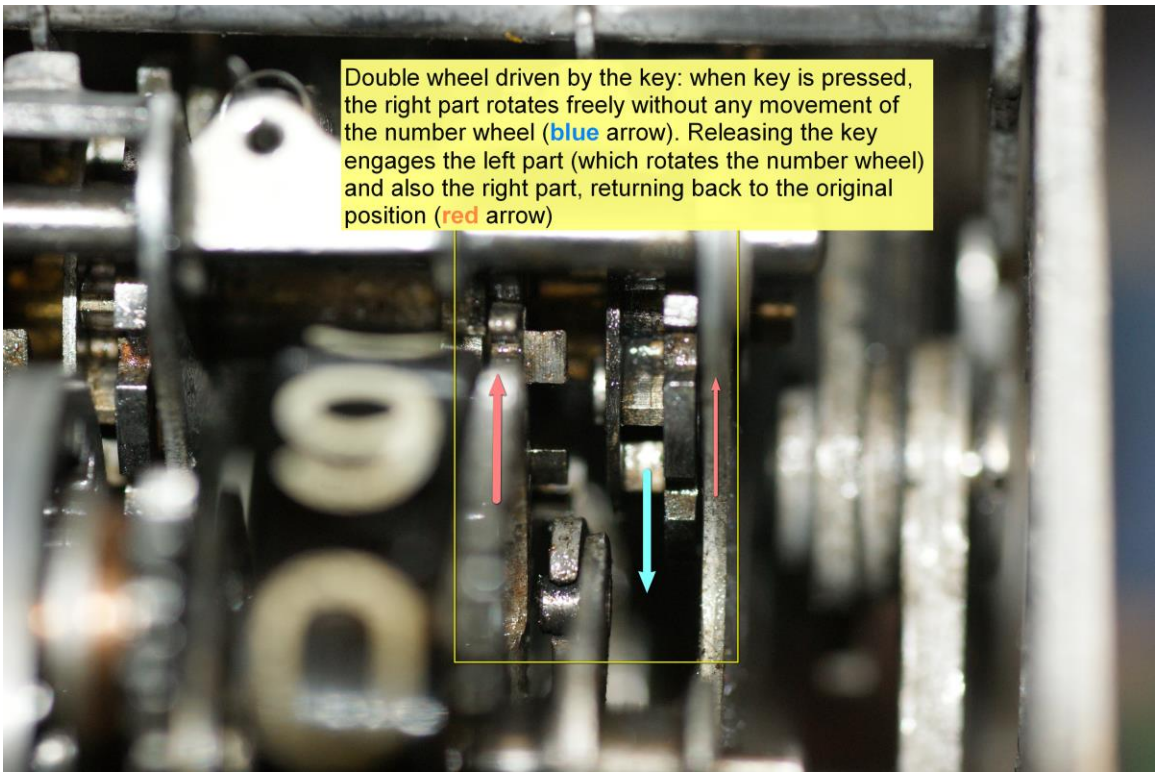

Fig. 21: The very important dual wheel assembly, at the right of the number wheels.

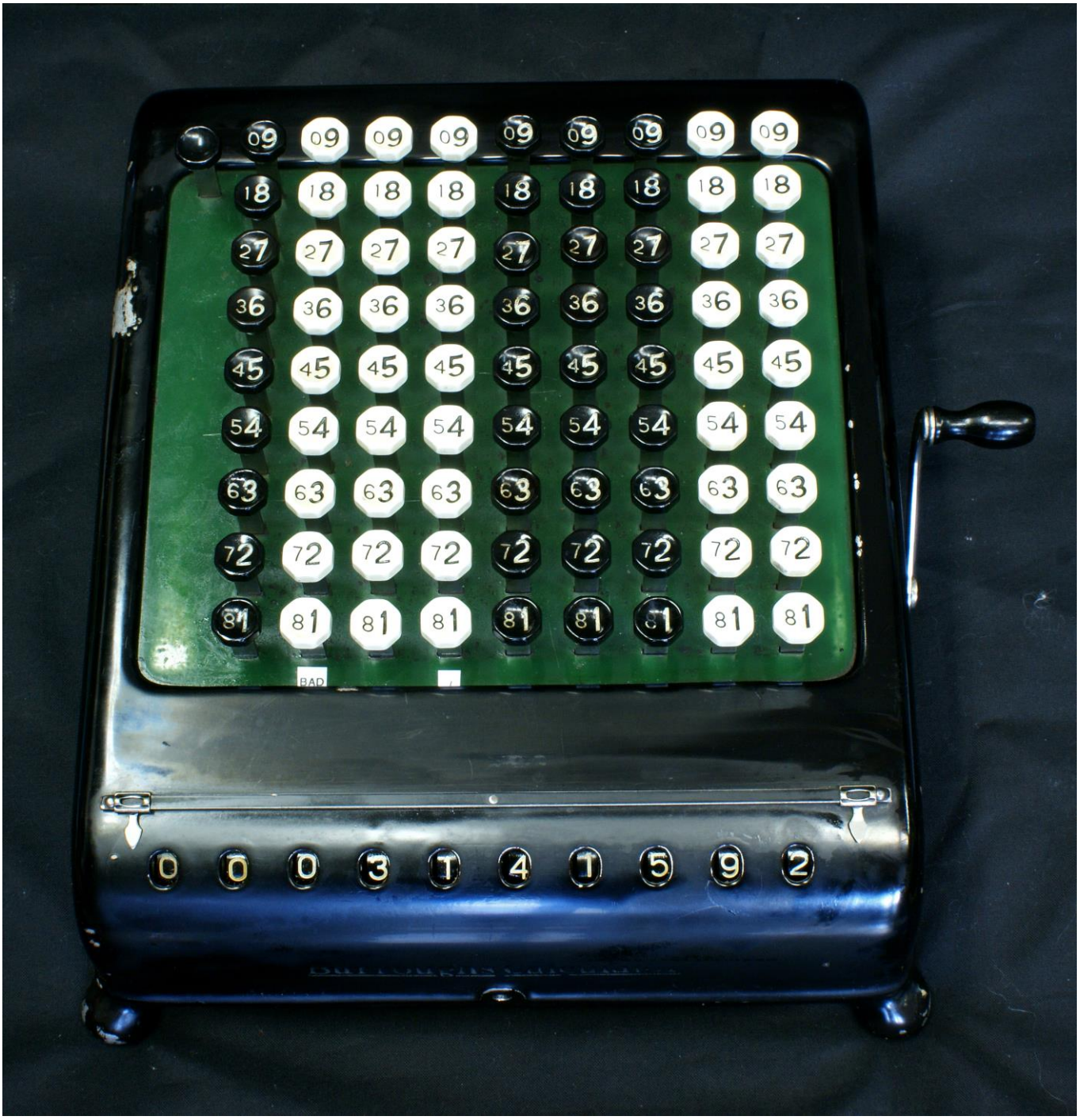

Fig.22: The restored machine in its enclosure; the Plexiglass cover below the numeral ovals has been removed, as it was damaged beyond repair.

Fig.23: View from the rear; only one of the cover screws (here at the left of the picture) is the original.

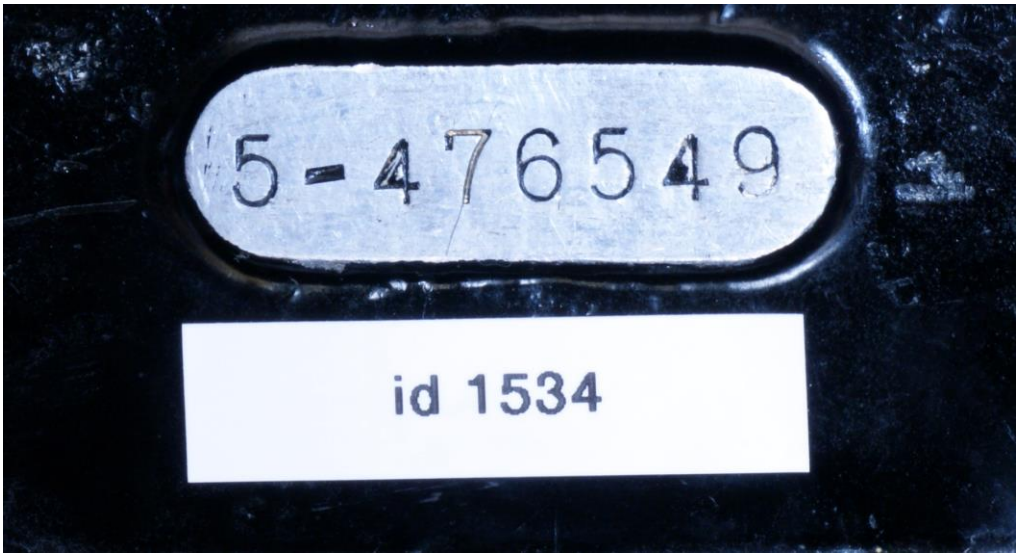

Fig. 24: Serial number and id of the Computarium database.

References:

1. John Wolff, http://www.johnwolff.id.au/calculators/

2. John Wolff, http://www.johnwolff.id.au/calculators/Tech/FTJ/Keyboard.htm

3. Prof. Christian-M. Hamann, http://public.beuth-hochschule.de/hamann/calc/index.html

4. YouTube: The ID of ED: Burroughs Class 5 & Comptometer Calculators long running survivors
   https://youtu.be/-kxZ6EKNtpo
5. YouTube: Joe Van Cleave, Dead Tech Review: Burroughs key operated adding machine
   https://youtu.be/EAW8pkK6Edc
6. http://www.burroughsinfo.com/when-was-my-machine-made.html#