

When Machines Learned to Write

The Wonderful History of Printing Telegraphy

• Teletype Model 15 • TG-7 •

Giovanni Becattini



References

The following references are used in this book:

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- [7KS] Tektronix 7000 Series – Elektor Books
- [TREG] Tektronix Oscilloscopes Restoration Guide – Elektor Books
- [TGHP] The Great Hewlett-Packard – Quacktech
- [VRE] Vintage Radio Equipment – Elektor Book
- [MAC] Apple Macintosh – History, Engineering, and Restoration – Elektor Books
- [QT602] The Good Giant – Tektronix DSA 602A Oscilloscope – Quacktech
- [QT11KP] The Last Plug-ins – Tektronix 11000-Series Plug-ins – Quacktech
- [SCL] Strumentazione Vintage – Edizioni C&C
- [QTCOL] Collins Classics – KWM-2, 30L-1 and 51S-1: History, Engineering, and Restoration – Quacktech Editions
- [QT324] Two Giants and a Shorty – Tektronix 323/324 - Quacktech
- [QTBYO] Become Your Own Publisher – Quacktech
- [QTHPSS] Hewlett-Packard Signal Sources – Quacktech
- [DAB] Digital but Analog – Quacktech

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Preface

Since the earliest times, mankind has sought to transmit information from one place to another in the shortest possible time. Yet only with the application of electricity to communication did this goal become truly achievable, and the Morse telegraph marked a radical turning point in the history of telecommunications.

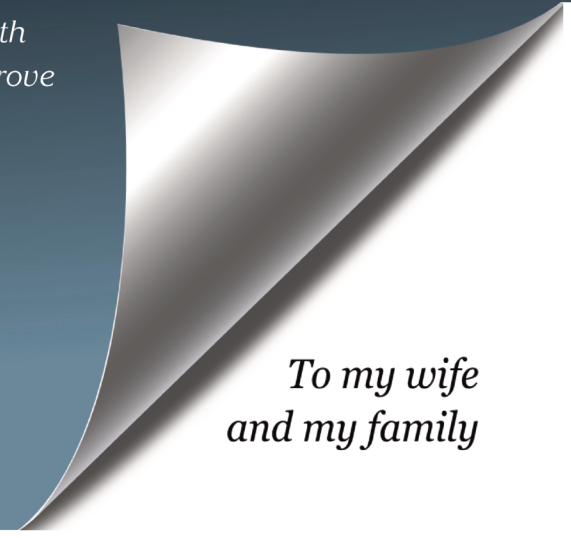
The Morse system, however, required skilled operators whose training was lengthy and demanding. It is therefore understandable that, from the very beginning, many inventors devoted themselves to finding solutions able to make message transmission more immediate, more automatic, and accessible to a wider range of users.

This book retraces that evolution, focusing on one of the most famous and widespread machines used from the 1930s to the early 1970s: the Teletype Model 15. For decades, it was a fundamental instrument for the transmission of written communications, finding application in civil, professional, military, and amateur radio contexts.

In the following pages, we will examine its mechanisms at close range, as ingenious as they are complex, together with the practical problems involved in restoration and return to service. The journey will culminate in the complete recovery of a machine that had remained inactive for more than ten years, finally restored to perfect working order.

This is my first book that deals neither with vacuum tubes nor with semiconductor devices. Yet for that very reason, I believe it may prove to be one of the most interesting I have written.

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*To my wife
and my family*

When Machines Learned to Write

The Wonderful History of
Printing Telegraphy



Historical Notes

Practical Information

Theory of Operation

Restoration

From Telegraph to Teletyping

Humans, of course, are never easily satisfied, and it did not take long before attempts were made to overcome these limitations. One interesting example can be seen in the illustration reproduced here (taken again from the book of my great-grandfather), which shows the Hughes telegraph.

The Hughes Telegraph

Among the early telegraph systems, the printing telegraphs developed by David Edward Hughes, Royal Earl House, and others were probably the most technologically sophisticated. These machines shared an important advantage with earlier alphabetic telegraphs: they did not require the use of symbolic codes such as Morse. Instead, the operator at the transmitting station used a keyboard that resembled a small piano, complete with black and white keys. Each key represented a letter or symbol of the alphabet. When a key was pressed, the corresponding character was automatically printed on a strip of paper at the receiving station. In other words, the system transmitted characters directly rather than requiring an operator to interpret coded signals.

Although conceptually elegant and technologically impressive, these systems were mechanically complex and required precise synchronization between the transmitting and receiving mechanisms. As a result, they proved more delicate and prone to operational difficulties than the simpler Morse system. In practice, the robustness and simplicity of Morse code eventually ensured its widespread dominance for many years.

Right: the Hughes telegraph, one of the earliest attempts to overcome the limitations of Morse telegraphy. Instead of requiring a trained operator to compose and interpret dots and dashes, it allowed messages to be sent directly as ordinary text.

Particularly striking is the use of a piano-like keyboard, with separate keys for letters, figures, and symbols. The resemblance was intentional: telegraph operators were already familiar with keyboards of this kind, and the inventor hoped to make the new machine easier and more intuitive to use. In this sense, the Hughes telegraph can be seen as one of the earliest ancestors of both the typewriter and the teleprinter.

Other Printing Telegraphy Attempts

The real solution to the limitations of Morse telegraphy arrived later in the nineteenth century with the development of **teleprinters**—machines capable of transmitting text through a keyboard similar to that of a typewriter and, even more remarkably, printing the message in plain text at the other end of the line.

Early experiments with printing telegraphy over wired circuits began surprisingly early. A telegraph circuit capable of supporting such operations was already in service between Philadelphia and New York City in 1849.

Émile Baudot

A major technological milestone was reached in 1874, when **Émile Baudot** introduced a telegraph system based on a five-unit code, a concept that remains fundamental to digital communication even today. Differently from what we often think, however, Baudot didn't invent the modern concept of the START-STOP serial transmission. This effective and practical industrial solution, however, didn't arrive until the first decades of the twentieth century. Among the many engineers who contributed to its development, one name stands out prominently: Edward Ernst Kleinschmidt.

Edward Ernst Kleinschmidt

Edward Ernst Kleinschmidt (1876–1938) was one of the most prolific inventors in the early history of teleprinter technology. Born in Bremen, Germany, in 1876, Kleinschmidt immigrated to the United States at the age of 8. He began experimenting with printing telegraph systems in the first decade of the twentieth century. His goal was to replace Morse telegraphy—which required skilled operators—with a system capable of transmitting ordinary typed text.

Over the following decades Kleinschmidt developed a remarkable number of inventions related to printing telegraphy. He obtained more than one hundred patents, covering subjects such as selector mechanisms, printing arrangements, synchronization systems, and methods for reducing the mechanical work required from the receiving electromagnet. Many of these patents describe ingenious ways of converting sequences of electrical impulses into precise mechanical motions.

Several of the principles found in later teleprinters—including the selector systems used in the Teletype Model 15 and its military derivative, the TG-7—can be traced directly to these early inventions. The patents examined in this book reveal just how sophisticated these mechanisms already were by the early 1930s.

The Morkrum Company

Joy Morton and Charles Krum

At roughly the same time that Kleinschmidt was developing his teleprinter designs, another group of engineers was pursuing a similar goal in Chicago. The Morkrum Company, founded by Joy Morton and Charles Krum, was also working on printing telegraph systems.

Charles Krum and his son Howard succeeded in building one of the first practical start-stop teleprinter systems, capable of transmitting characters encoded in the five-bit Baudot code and printing them automatically at the receiving station. Their machines demonstrated that automatic telegraphy could be made reliable enough for commercial use.

By the 1910s and 1920s, two separate technological lines had therefore emerged:

- **Kleinschmidt Electric Company** with Edward E. Kleinschmidt: selector mechanisms and printing systems
- **Morkrum Company** with Charles and Howard Krum: practical start-stop teleprinters

Both companies held important patents, and both were advancing toward similar technical solutions.

Left: an image taken from the 1958 leaflet *The Teletype Story*. In the foreground appears what is described simply as an “early page printer”. In “Printing Telegraphy, A New Era Begins” the same machine is more precisely identified as the “Morkrum Company’s Blue Code Typewheel Page Printer”.

The name “Blue Code” did not indicate the model itself, but the particular version of the Morkrum page printer developed for the Postal Telegraph Company, whose identifying color was blue. The machine used a typewheel and could print directly in ordinary text, representing one of the earliest practical attempts to move beyond Morse code and toward true page printing telegraphy.

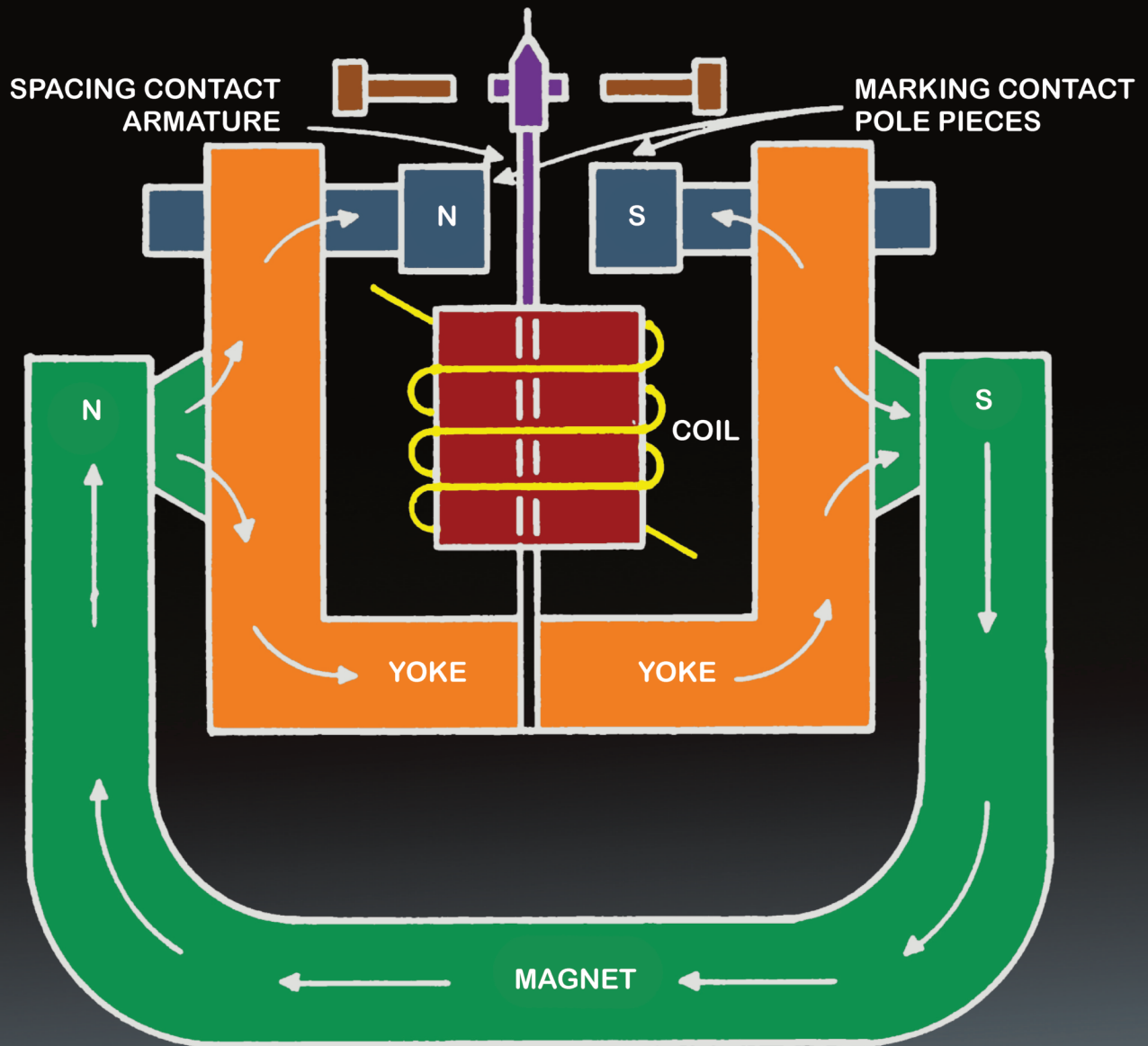
In the background, by contrast, appears what the leaflet calls “a modern communication center”, populated by several Model 15 machines. The contrast is striking: only a few decades separate the primitive but visionary Blue Code printer from the elegant, mature form reached by the Model 15, yet together they represent the same long effort to make telegraphy speak in plain language rather than in dots and dashes.



Modern communications center.



Early page printer



Above: Principle of operation of a polar relay. It works rather like a moving-coil galvanometer, with the contacts suspended in the field of a permanent magnet and moving one way or the other according to the polarity applied to the line. Before the arrival of vacuum tubes and semiconductors, it was probably the best solution available for reliable long-distance communication: a small electromechanical compass needle, faithfully pointing toward either +115 V or -115 V across hundreds of kilometers of wire.

hear whether a distant bell is ringing or silent. In a polar system, by contrast, the receiver distinguishes between “current flowing one way” and “current flowing the other way,” a much clearer electrical conversation, like a seesaw that always tips to one side or the other.

FROM WIRES TO AIR



Radio Tele Type

RTTY

We mentioned earlier that, as early as 1922, the first successful demonstrations of air-to-ground printing telegraphy had already taken place. These experiments showed that written text could be transmitted automatically over radio waves almost as effectively as over wires, opening the way to what would later be known as radioteletype.

Radioteletype, usually abbreviated as RTTY, is a form of telegraphic communication in which radio signals are generated according to the electrical impulses produced by a teleprinter keyboard, and in which a received radio signal is converted back into the impulses required to print characters on a distant teleprinter.

This new capability greatly extended the possibilities of printing telegraphy. A transmitting station could now be received over great distances, even worldwide, without any physical connection between sender and receiver. RTTY therefore became an ideal medium for press agencies, political organizations, military services, and eventually radio amateurs as well.

From Wires to Air

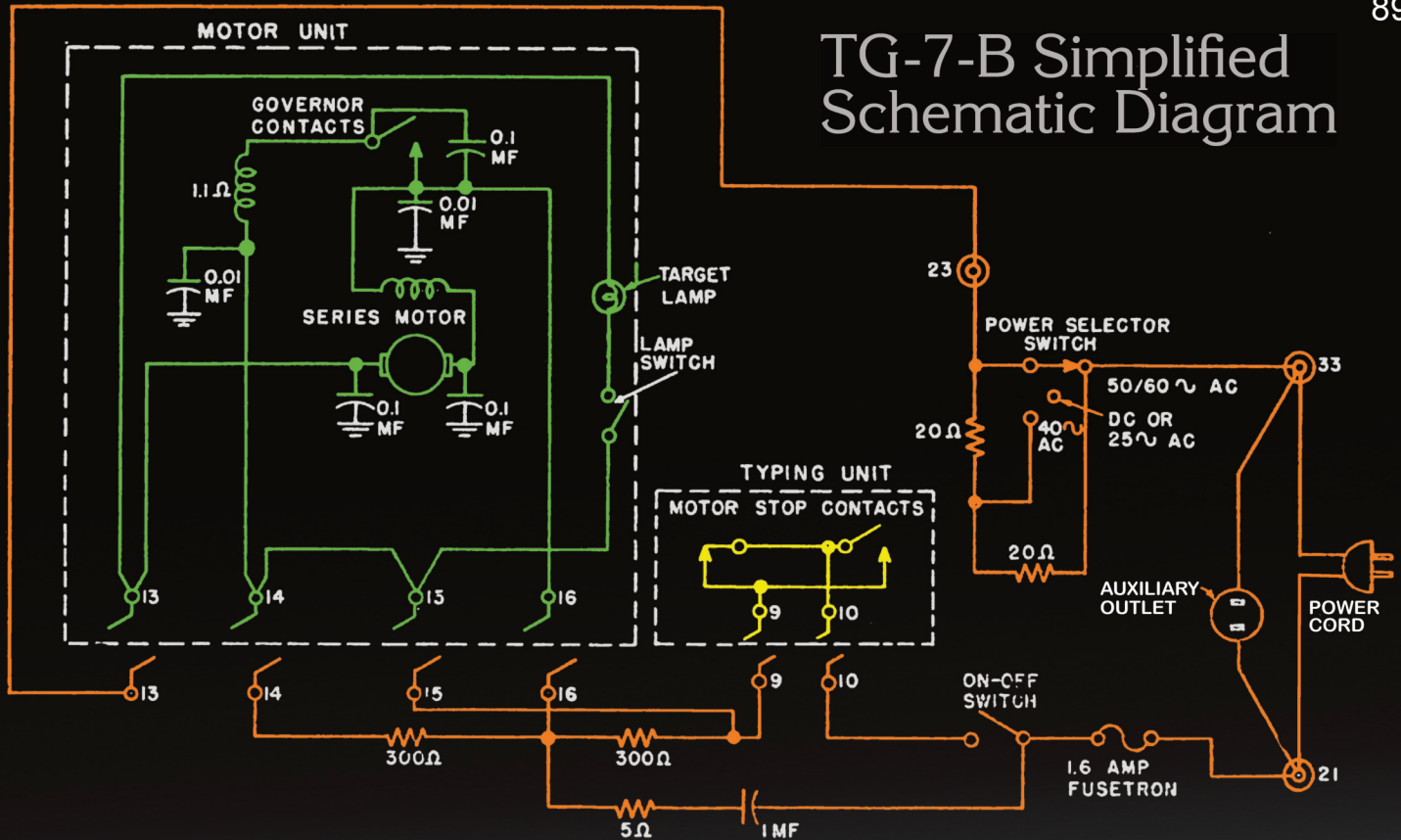
So the the question was: how to convert the two electrical states of a teleprinter line into something that could be transmitted through the air?

Two main approaches emerged: Audio Frequency Shift Keying (AFSK) and Frequency Shift Keying (FSK). In SSB systems, AFSK is in fact a “disguised FSK”, because the two audio tones are translated into two RF frequencies within the sideband.

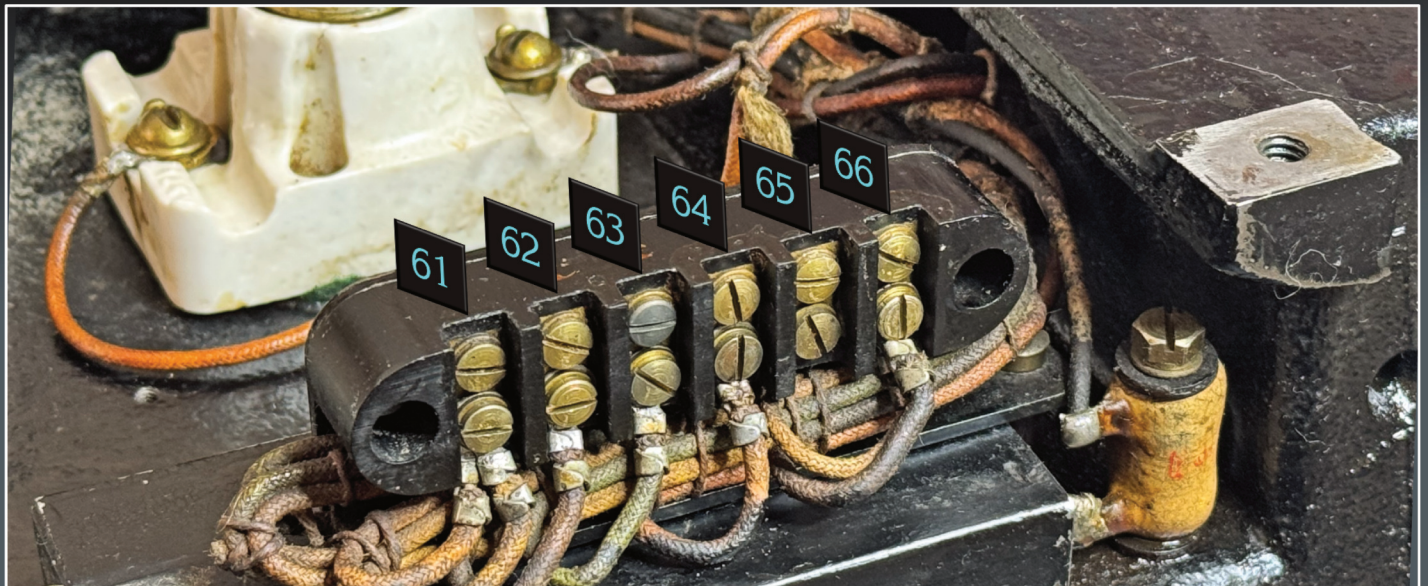
Audio Frequency Shift Keying (AFSK)

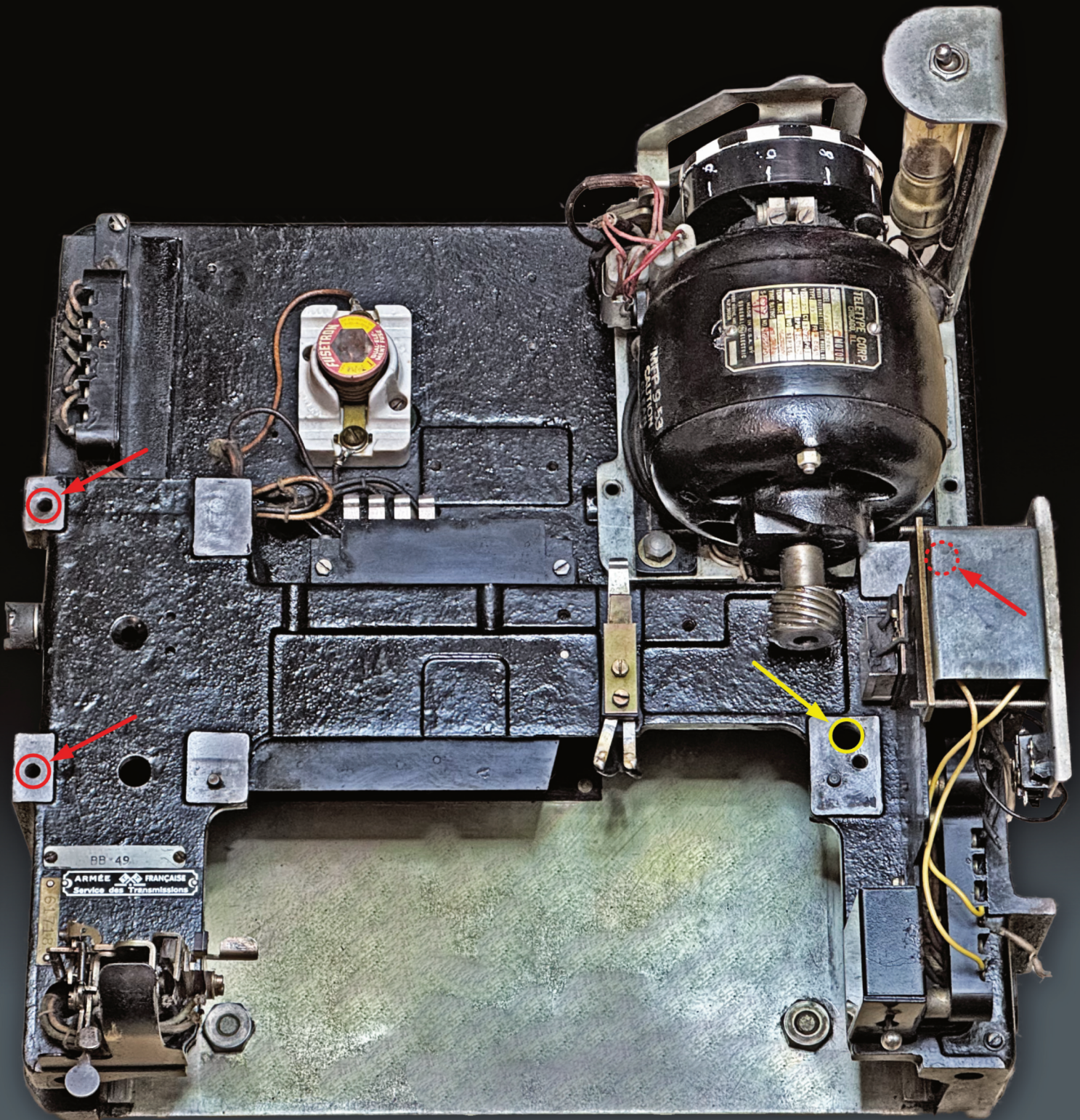
The simplest method is AFSK, in which two audio tones represent the MARK and SPACE conditions of the teleprinter signal. A common example uses tones such as 2125 Hz for MARK and 2975 Hz for SPACE, corresponding to an 850 Hz shift.

TG-7-B Simplified Schematic Diagram



Below: the secondary terminal block, in the left rear part of the machine. It was probably used when a line relay was installed.





Selection is made via a switch on the front panel, protected by a metal bracket. This switch inserts one or two large resistors into the circuit, housed in a flat enclosure on the right-hand side of the unit. When operating at 50 or 60 Hz, these resistors are not required and were often removed. In my unit, they are still present but have been electrically bypassed, preventing any incorrect switch setting.

Also worth noting are:

- the **mains switch**;
- a **power receptacle** for auxiliary equipment;
- a **lamp** with its own switch, intended to facilitate motor speed adjustment.

As can be seen from the image on the right, the construction is remarkably clean. All connections between the base and the mechanical modules are made through contact interfaces, with no loose wiring.

A particularly refined feature is the so-called **LINE JACK**, which automatically shorts the line to the selection magnet when the typing unit is removed from the base. This allowed maintenance personnel to operate in the field without interrupting the communication line (*in early telegraph and telephone equipment, the term jack did not necessarily imply a plug-and-socket connector as we think of today.*)

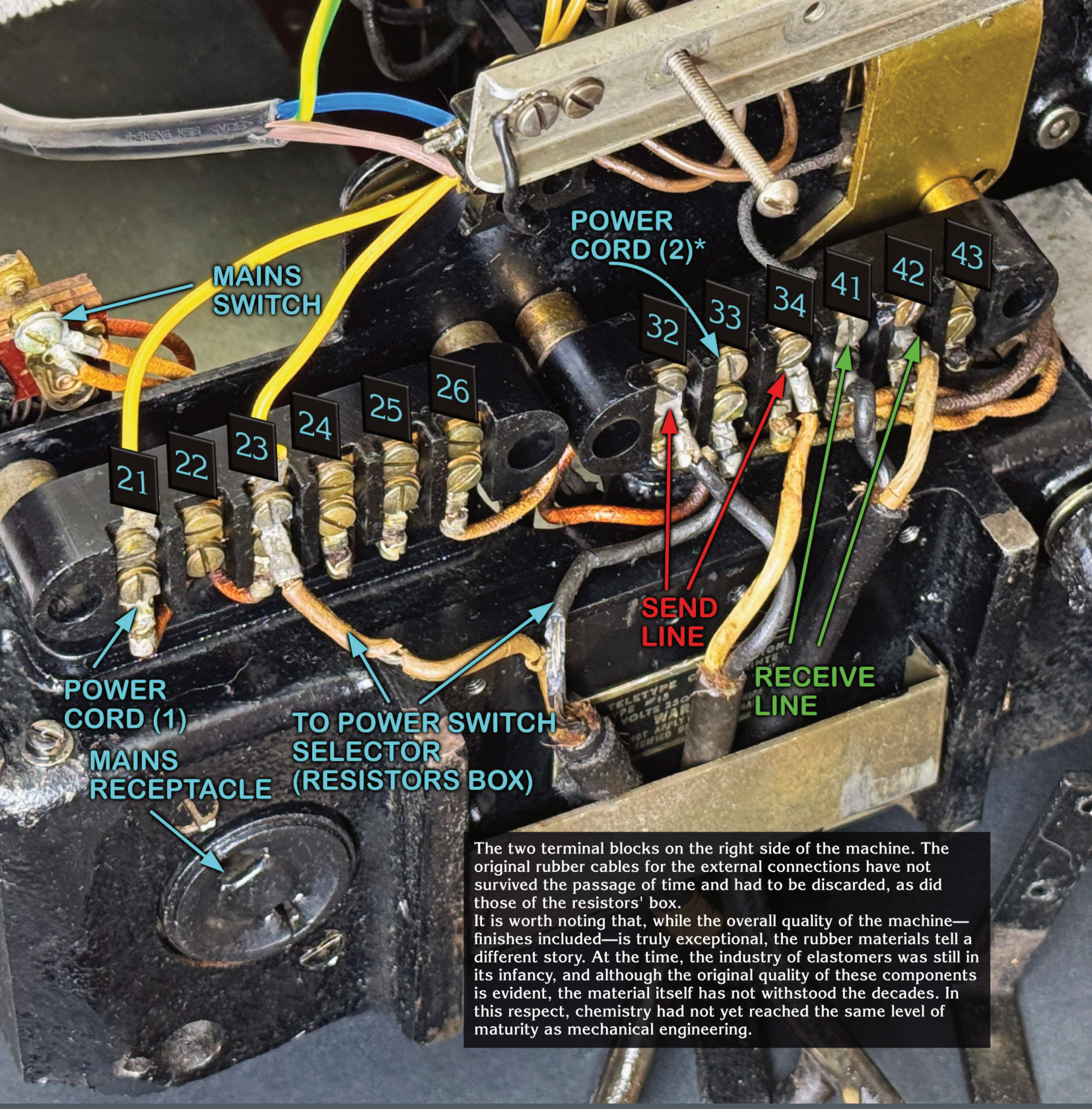
The motor itself uses self-connecting contacts, meaning it can be removed without disconnecting any wires.

Three terminal blocks are present:

- the two on the right are used for power and data connections;
- the third, on the left side, has only a few wires connected and no clearly documented purpose (see photos on the previous and next pages).

Several capacitors are used to suppress electrical noise generated by the brush motor. A later engineering modification introduced an additional line filter on the AC input. The original machine, dating back to the 1930s, was most likely used as a wired telegraph terminal, where electrical noise was of little concern. With the introduction of RTTY, however, interference became a much more significant issue.

If you think that modularity is a modern concept, take a look at the Model 15, you may be in for a surprise. The entire machine can be dismantled in a matter of minutes, with no wiring linking the various modules. The motor is secured by just three hex-head bolts; the typing unit by three thumb screws (in red in the photo on the left). My unit had a fourth screw with a hex head (in yellow), although not mentioned in the manual. The keyboard can be removed simply by loosening two captive thumb screws.



MAINS SWITCH

POWER CORD (1)
MAINS RECEPTACLE

TO POWER SWITCH SELECTOR (RESISTORS BOX)

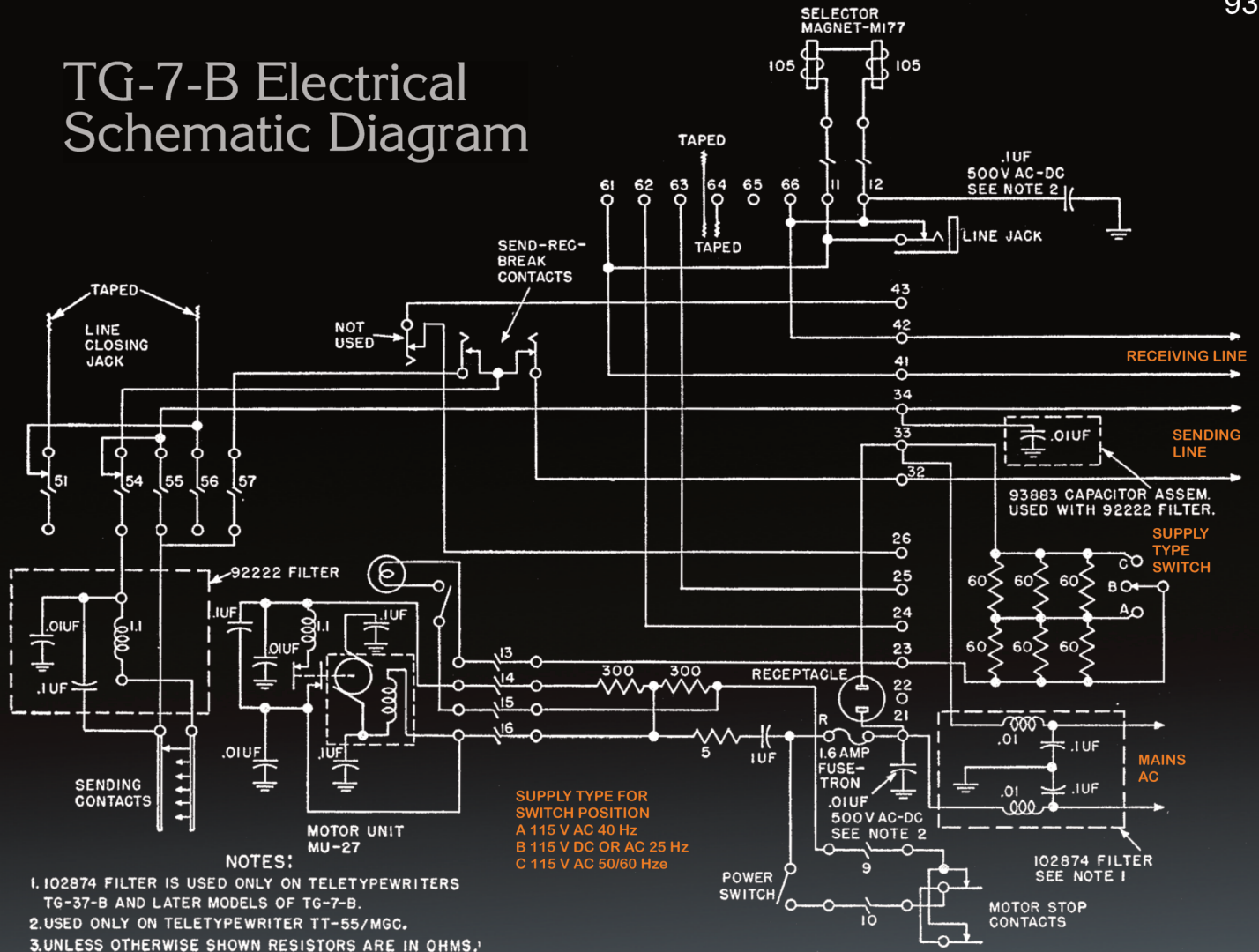
POWER CORD (2)*

SEND LINE

RECEIVE LINE

The two terminal blocks on the right side of the machine. The original rubber cables for the external connections have not survived the passage of time and had to be discarded, as did those of the resistors' box. It is worth noting that, while the overall quality of the machine—finishes included—is truly exceptional, the rubber materials tell a different story. At the time, the industry of elastomers was still in its infancy, and although the original quality of these components is evident, the material itself has not withstood the decades. In this respect, chemistry had not yet reached the same level of maturity as mechanical engineering.

TG-7-B Electrical Schematic Diagram



Data Circuit

We have already discussed the typical teletype circuit, including the magnet and the Baudot data flow. It is worth adding that the **magnet** was designed to be driven by a vacuum tube, and therefore has a relatively high impedance.

In my measurements, I found:

- resistance: 206 ohms
- inductance: 0.57 henries

Other Details

Two additional aspects are worth mentioning:

- **the motor stop circuit**, which allows the motor to be switched off upon reception of a specific character (this will be discussed later, when examining the TG-7 functions);
- **the motor speed control**, which will be described in the next chapter dedicated to the motor.

The complete electrical schematic diagram is shown on the following page.

Below: the resistor box. These are used when operating at frequencies lower than 50 Hz or with a DC power supply. As noted on the previous page, the fabric-covered wires appear to have withstood the passage of time better. It is possible that, internally, they are not in perfect condition; however, being tightly bound and essentially immobile, any deterioration of the insulating material does not lead to immediate problems.

This highlights an interesting contrast: while rubber components—despite their original quality—tend to deteriorate over time, textile-based materials prove to be far more stable. The fabric covering itself appears to be impregnated or “varnished,” which likely contributed to its mechanical strength and long-term durability.

Here again, one can appreciate the accuracy of the construction, as well as the quality of the materials and the finish.

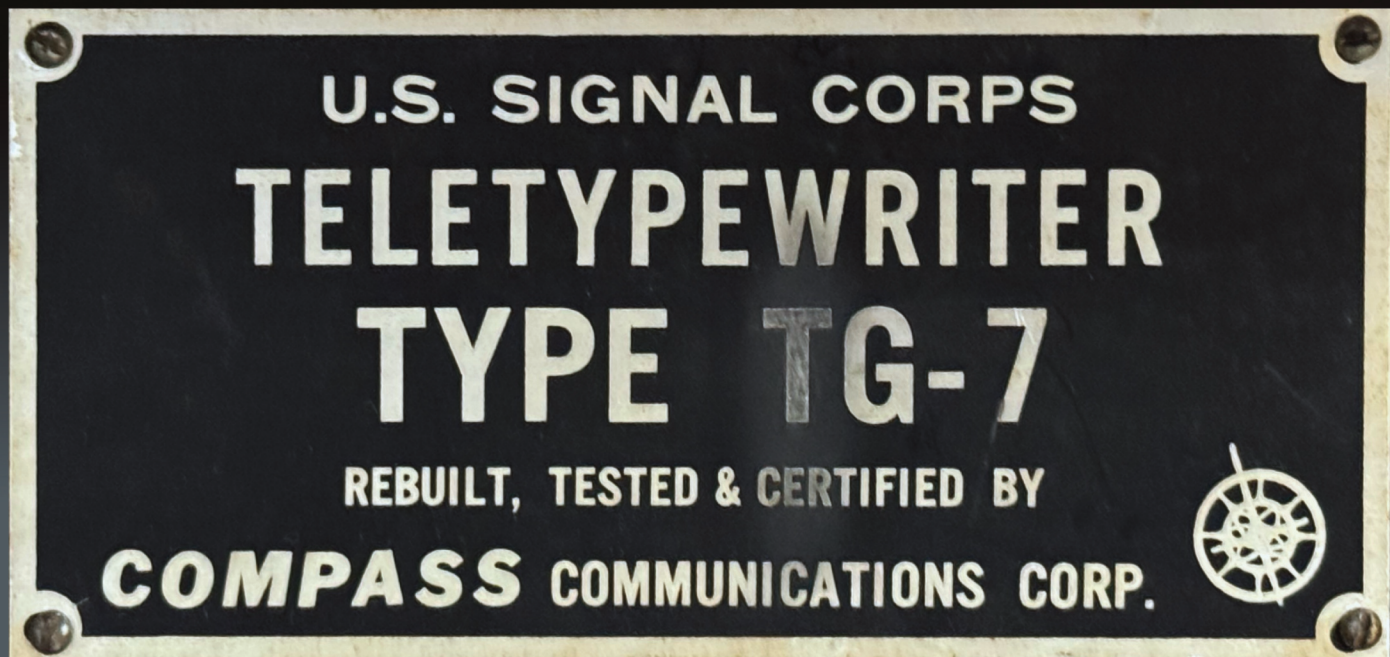




The labels cast in metal, now appear almost as small works of art. The elegant "Teletype" script, flowing along a ribbon-like form, clearly reflects the Liberty (Art Nouveau) style of the period

Several aspects confirm this early origin: for example, the very heavy cast-steel base, typical of early industrial design, and the beautifully made cast labels with raised lettering shown on the next page.

My TG-7 appears to have originally been a Model 15, or at least the main label located in the terminal block area suggests this (1). Another important clue is the



118 In addition, it holds the armature extension arms firmly in position while the sword arms interfere with them during their positioning. **The logical equivalent here is a latch** (such as the SN7474), which stores the bit.

But above all, the LOCKING LEVER implicitly defines the **sampling instant** of the received bit — effectively acting as the clock for the latch. The “decision” occurs at the precise moment when the two wedges settle into position; from that instant onward, what happens on the line is no longer relevant. If it was MARK, it remains MARK; if it was SPACE, it remains SPACE.

Note that the LOCKING LEVER is actuated by the LOCKING CAM. When the lever rides on the high portion of the cam, the locking-lever extension is held away from the locking wedge, and the armature is free to move in response to the incoming signal.

As the sword arms are positioned — striking the armature extension arms — the LOCKING LEVER drops into the depressions of the locking cam and locks the armature firmly in place.

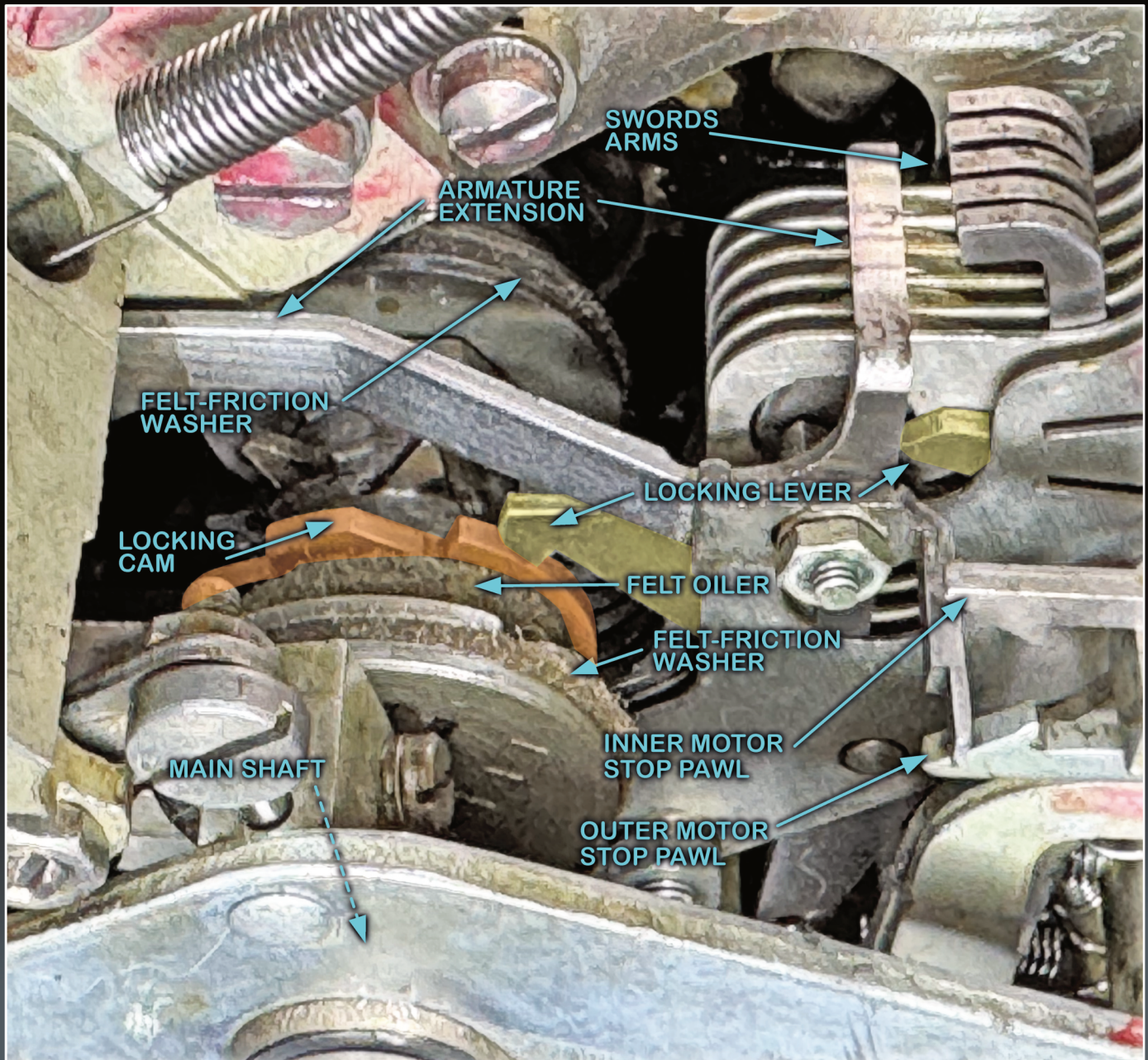


Summary of the Above

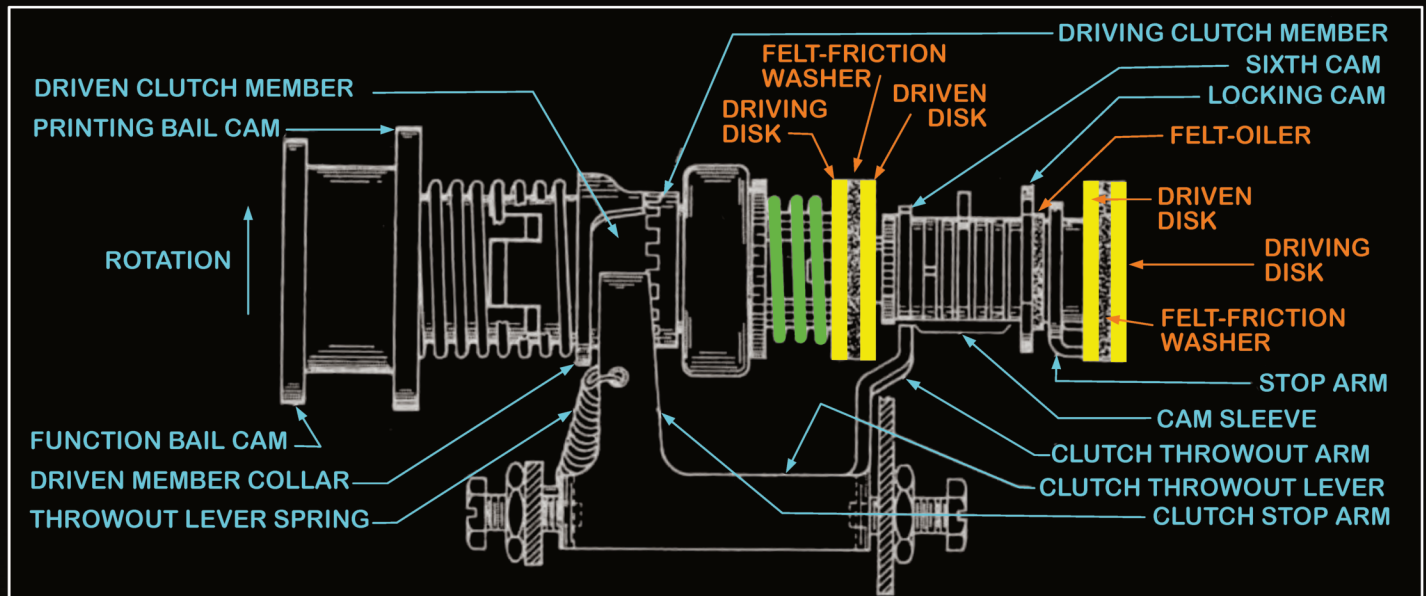
We have seen above:

- how a selector is built and how it works;
- the LOCKING LEVER, which determines the sampling instant.

Let us now examine how the complete selection cycle operates.



Above: seen this way, the understanding of the LOCKING LEVER mechanism is much easier. Note highlighted the LOCKING CAM (orange) and the LOCKING LEVER (yellow). This "3D view" of selector details is easier to understand than the 2D manual drawings. Clear visible also the two friction clutches base on felt washer compressed between two flat disks. A third felt washer is used as an oiler. All must be soaked in oil. I used Singer sewing machine oil bought on Amazon.



Above: Rightmost portion of the MAIN SHAFT seen from the rear and top of the machine, clearly showing, also thanks to the colors, some of the TG-7 secrets you couldn't imagine by simple observation. Note the CAM SLEEVE which carries the 5 data CAMS, driven by two friction clutches, normally kept still by the STOP ARM. It carries also the SIXTH CAM that acts on the CLUTCH THROWOUT LEVER. The drawing is not very clear: normally the PRINTING/FUNCTION BAIL CAM is not engaged and the cams stay still. When the SIXTH CAM raises the CLUTCH THROWOUT ARM, the CLUTCH STOP ARM raises and allow the clutch to engage. Thus, the PRINTING/FUNCTION CAMS start to rotate at the end of the selection cycle. After a quasi-complete turn, the clutch opens again, stopping the PRINTING/FUNCTION CAMS which completed their cycle.

Under normal conditions the line is in the MARK state, so the selector magnet is energized. When the START impulse of a character arrives (SPACE condition, open line, no current), the selector magnet releases the CAM SLEEVE, which is then carried along by its friction coupling and begins its cycle.

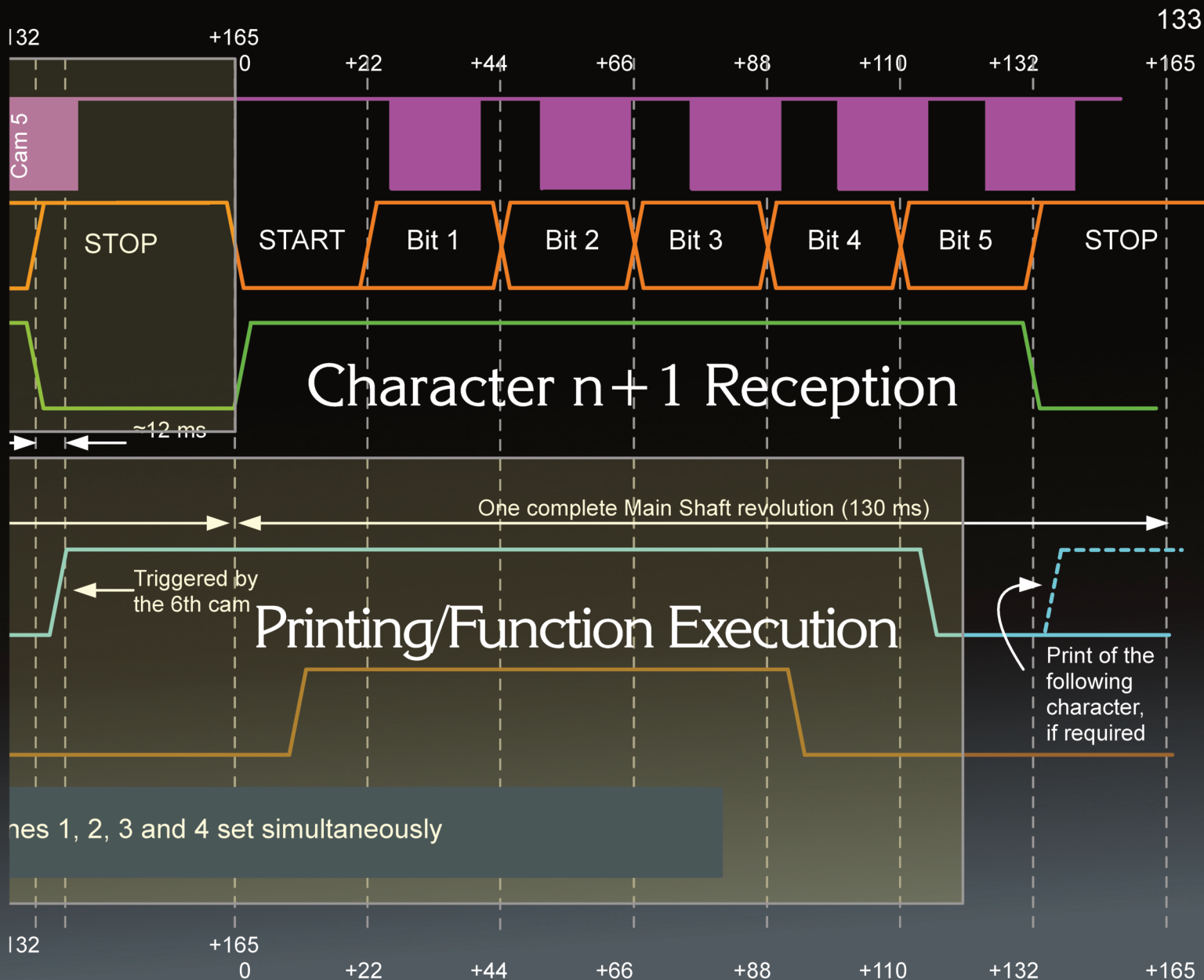
The manual does not specify the phase relationships between the cams. Without this information the description would not be complete, and therefore it is worth spending some time on the subject. We must rely partly on reasoning and partly on measurement.

What Logic Suggests

The START impulse lasts 22 ms, and during this time the cam begins to rotate, but in those first milliseconds little happens: the selector is essentially waiting.

It seems reasonable to:

- sample the first bit after the START pulse, **in the middle of the first data bit**, that is $22 + 11 = 33$ ms from the beginning of the START pulse;
- sample the following bits every 22 ms, that is at 55, 77, 99, and 121 ms.



Above: the reconstructed timing diagram showing the overlap between the selection cycle and the printing/function cycle. No diagram of this kind is provided in the manual, so it had to be derived through successive approximations.

The 25 ms sampling intervals correspond to those actually used in the TG-7, even though the underlying logic would suggest 22 ms; some possible explanations for this discrepancy are discussed in the text.

In contrast, the timing of the first sampling instant relative to the **START** pulse is not fixed, but depends on the setting of the Range Finder ("phasor"), and is therefore arbitrarily chosen in this diagram.

Particularly noteworthy is the 3-bit latching function.



Section:

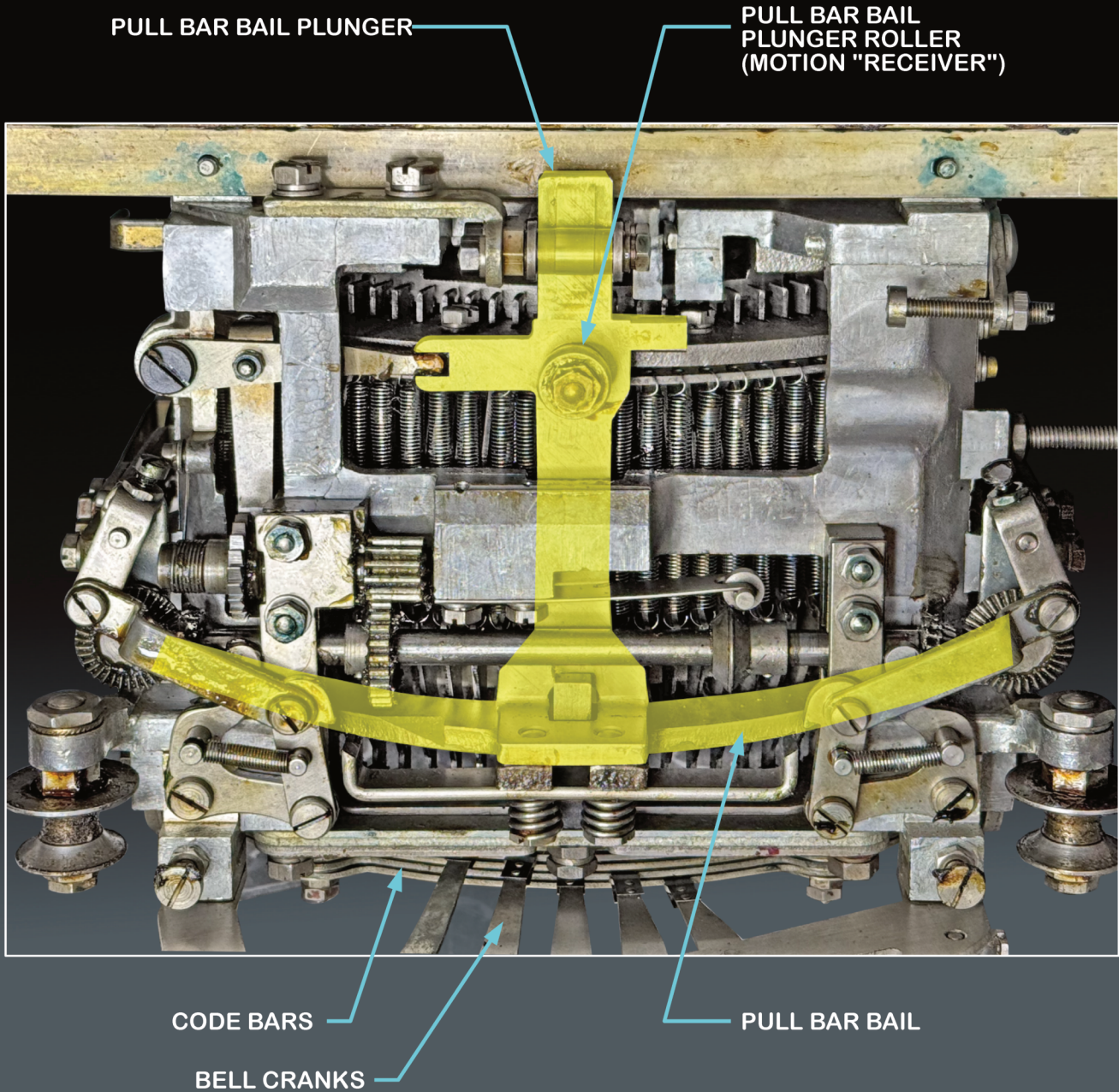
Theory Of Operation

Subsection:

Printing etc.

How the actual printing and the related functions are performed:

- character-by-character carriage advance and end-of-line stop
- right margin warning bell
- ink ribbon feed

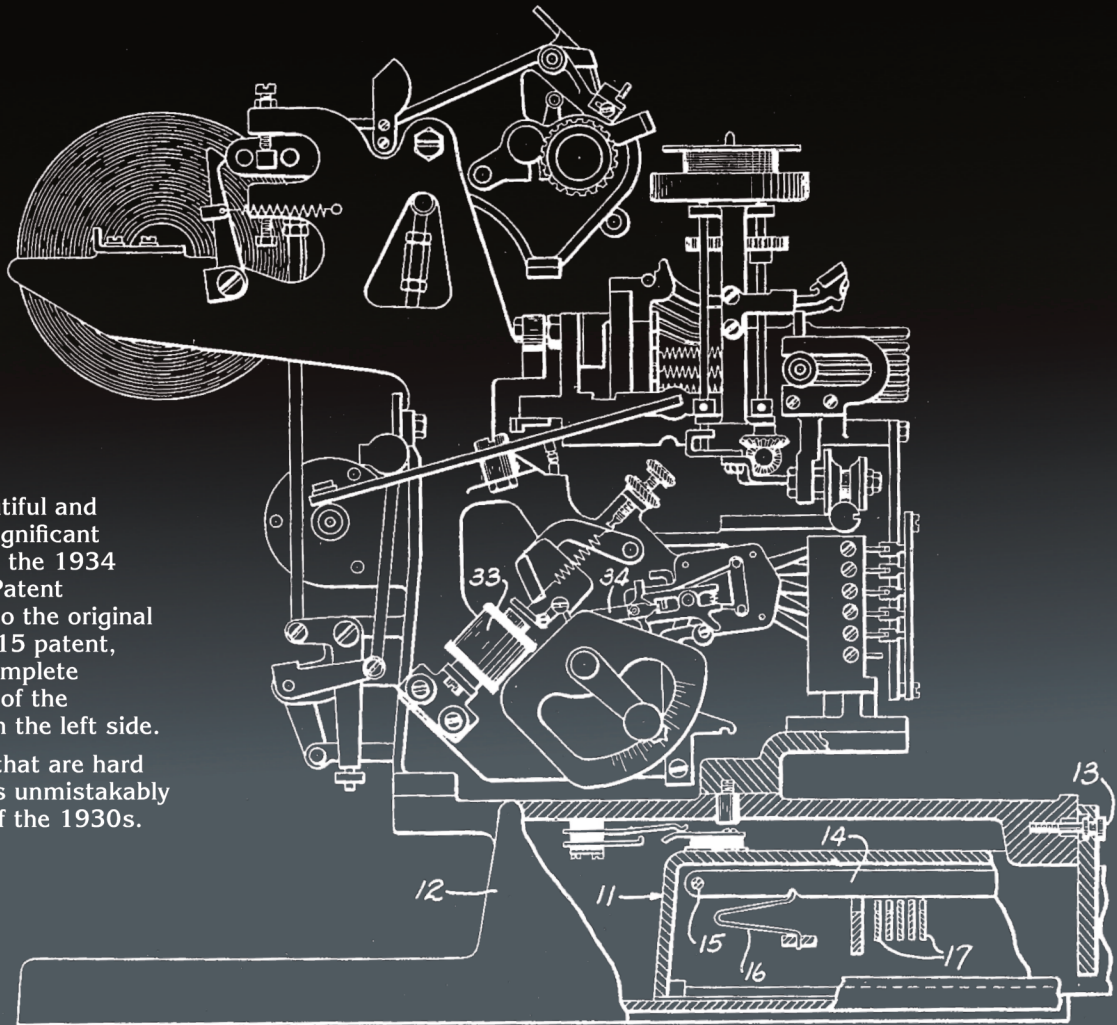


Above: this photo clearly shows the **PULL BAR PLUNGER**, which receives motion from the **PRINTING BAIL** and actuates the **TYPE BARS**. It also provides the energy required for the ribbon motion, described later. I had tried to visualize it from the drawings in the manual—but only when seeing it in operation does its role become fully clear.

In essence, the PRINTING BAIL acts as a mechanical bridge, transferring the precisely timed motion generated by the main shaft to the movable type-bar carriage without interfering with its lateral movement. 145

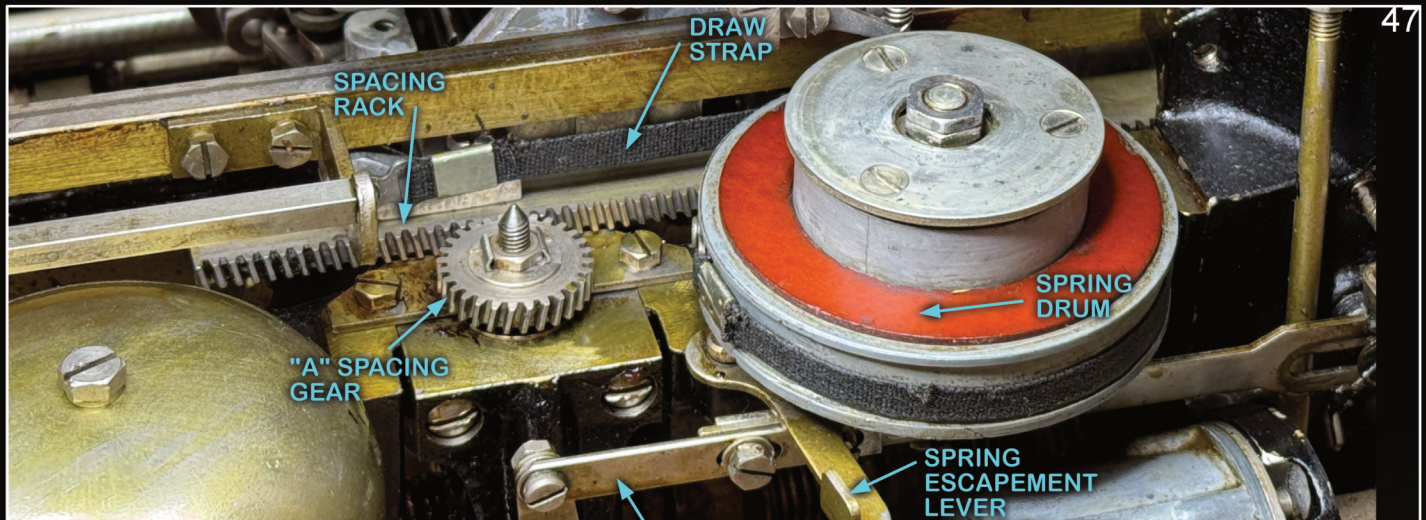
At the end of each revolution of the PRINTING-BAIL CAM, the PRINTING-BAIL OPERATING-ARM roller comes to rest on the high portion of its cam. The PRINTING BAIL is then in its extreme rear position, carried there against the tension of the PRINTING-BAIL spring.

FIG. 2



Right: a beautiful and historically significant drawing from the 1934 update (US Patent 1,980,284) to the original 1933 Model 15 patent, showing a complete internal view of the machine from the left side.

For reasons that are hard to define, it is unmistakably in the style of the 1930s.



Gears Driving The Carriage

The movement of the carriage is supported by three rollers: two running on the front track and one on the rear track.

Understanding how the carriage is driven forward is straightforward: just look at its rear side (see photo above). The carriage is advanced by the “A” SPACING GEAR, which meshes with the SPACING RACK, a linear gear.

Question: The question then becomes: who drives the “A” SPACING GEAR?

Answer: The “A” gear is mounted on a vertical shaft which carries, at its lower end, another gear: the “B” SPACING SHAFT GEAR. This, in turn, engages the “C” SPACING GEAR mounted on the MAIN SHAFT (figures on the next pages.)

Summarizing:

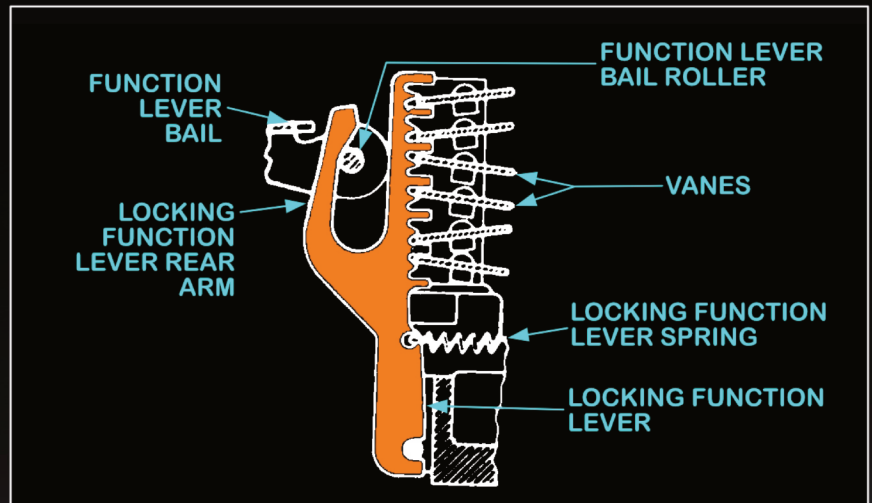
- “A” SPACING GEAR – the gear mounted at the top of the spacing shaft, engaging the spacing rack.
- “B” SPACING SHAFT GEAR – the gear at the lower end of the spacing shaft, which engages the main-shaft gear through a clutch, allowing the carriage-return function described later.
- “C” SPACING GEAR – the gear mounted on the main shaft (by means of a friction clutch, as will be discussed shortly).

To avoid confusion, I added the names A, B and C to the gears, which otherwise have very similar names.

Specific Functions

FUNCTION LOCKING Lever

Let us begin with an internal function already mentioned several times: the FUNCTION LOCKING LEVER. Its purpose is to hold the VANES in their selected position until a character is printed or a function has been completed. During this time, the selector is already receiving the next character and storing it for the following cycle, when the FUNCTION LOCKING LEVER will be released.



Above: the FUNCTION LOCKING LEVER “freezes” the vanes in their current position. Any new incoming bits are latched in the selector.

The locking function lever is the first on the right among the function levers, which are mounted behind the vanes (see the figure on the right).

When the printing bail moves forward, the function-lever bail roller moves downward, leaving the high portions of the rear arm of the function lever. This allows the locking function-lever spring to pull the lever against the rear edges of the vanes.

In this position, the FUNCTION LOCKING LEVER engages each vane — whether in the marking or spacing position — effectively locking them in place until the printing-bail cam has completed its rotation.

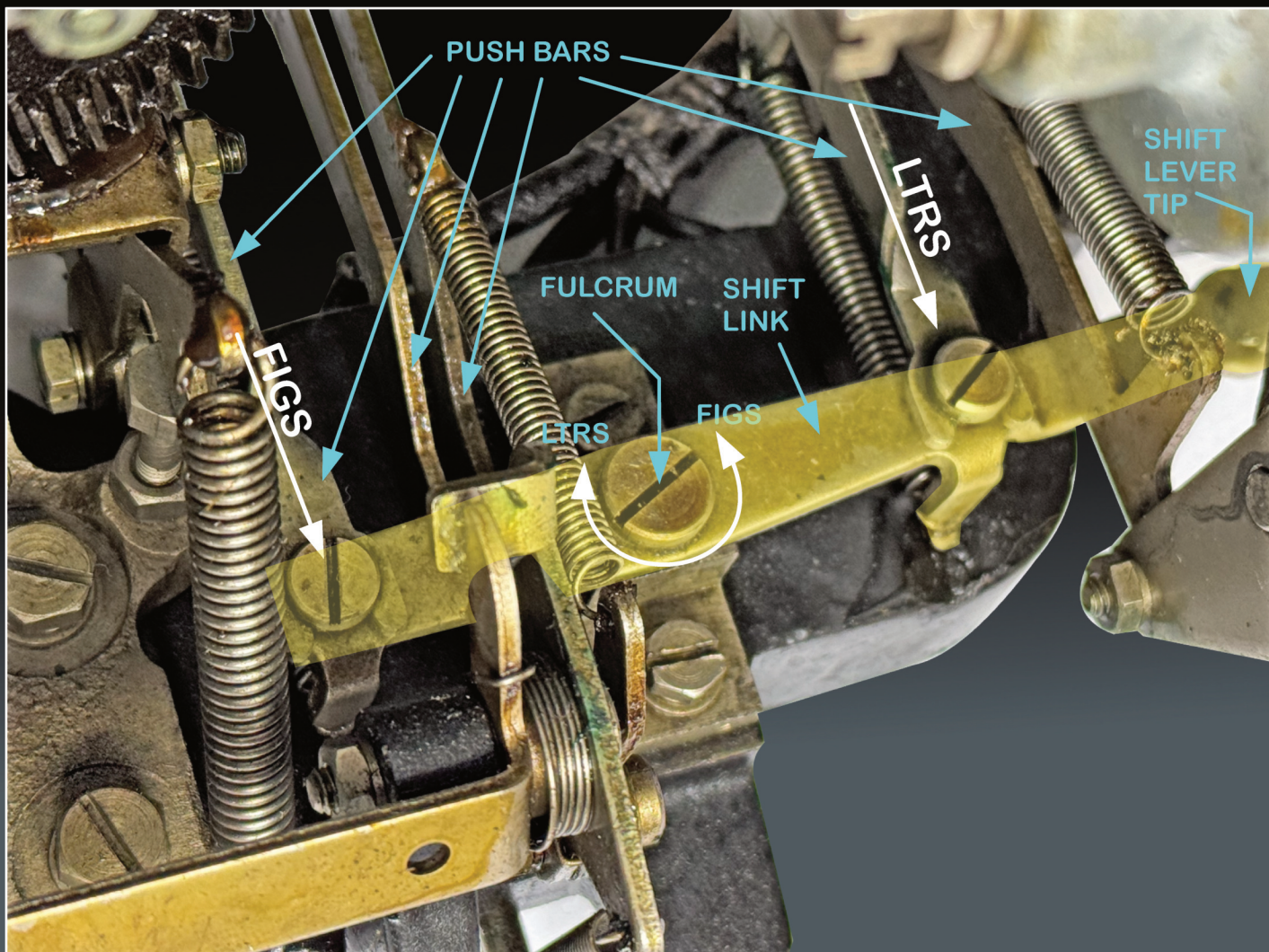
A glance at the picture makes this mechanism immediately clear.

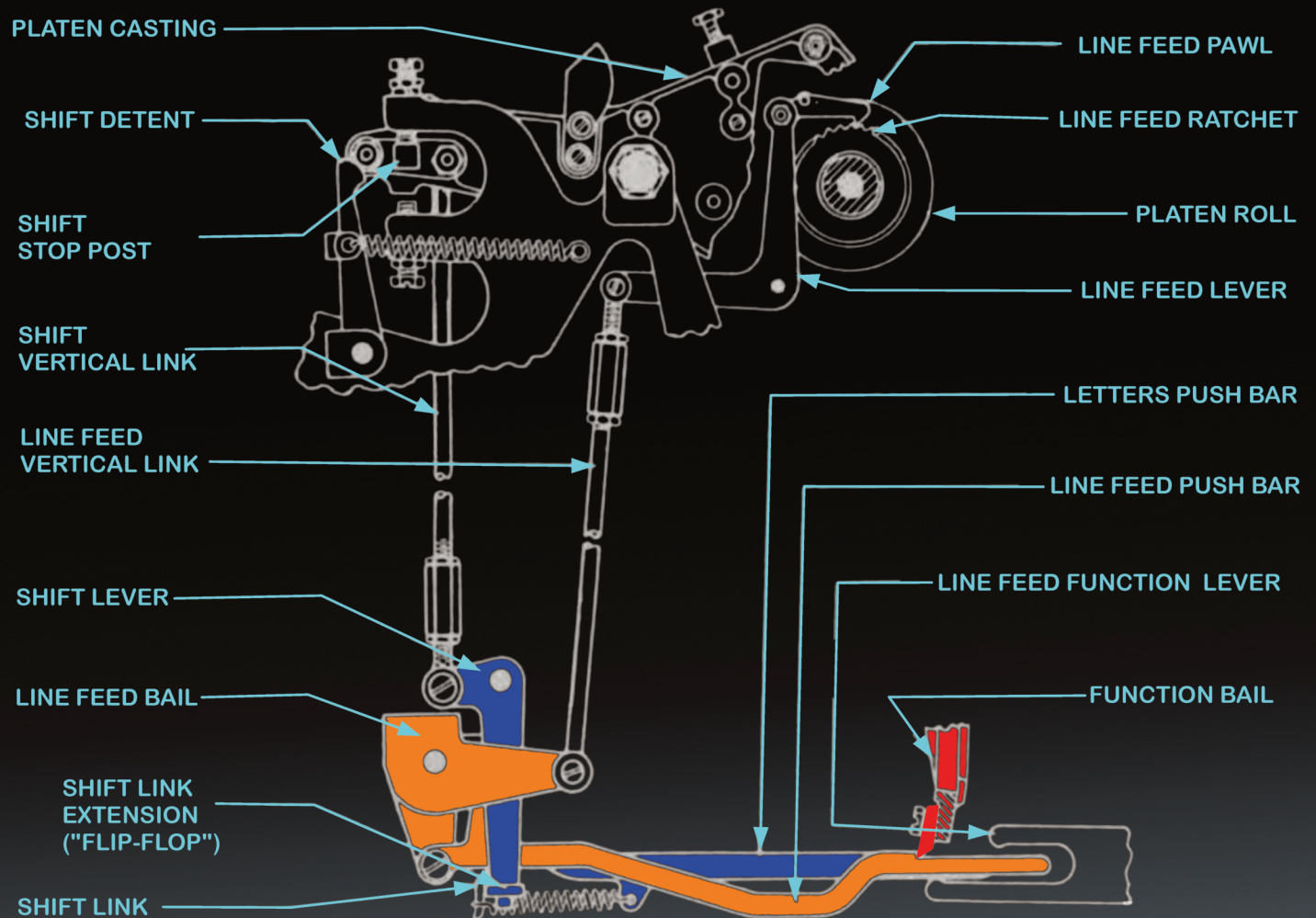
In modern terms, this device acts as a sort of mechanical buffer between two consecutive cycles: while one character is being physically realized, the next one is already being prepared.

172 FIGS and LTRS Functions

The FIGS and LTRS functions are best described together, since they are obviously linked: FIGS cancels LTRS and vice versa, effectively forming the mechanical equivalent of a flip-flop.

From the figure on the left it is easy to understand how the mechanism works. When the LTRS PUSH BAR is actuated by the FUNCTION BAIL, the SHIFT LEVER pulls the SHIFT VERTICAL LINK upward. This action moves the PLATEN ROLL into the lower position, enabling the printing of letters. The SHIFT DETENT ensures that the two states — FIGS and LTRS — remain stable, as clearly shown in the figure.

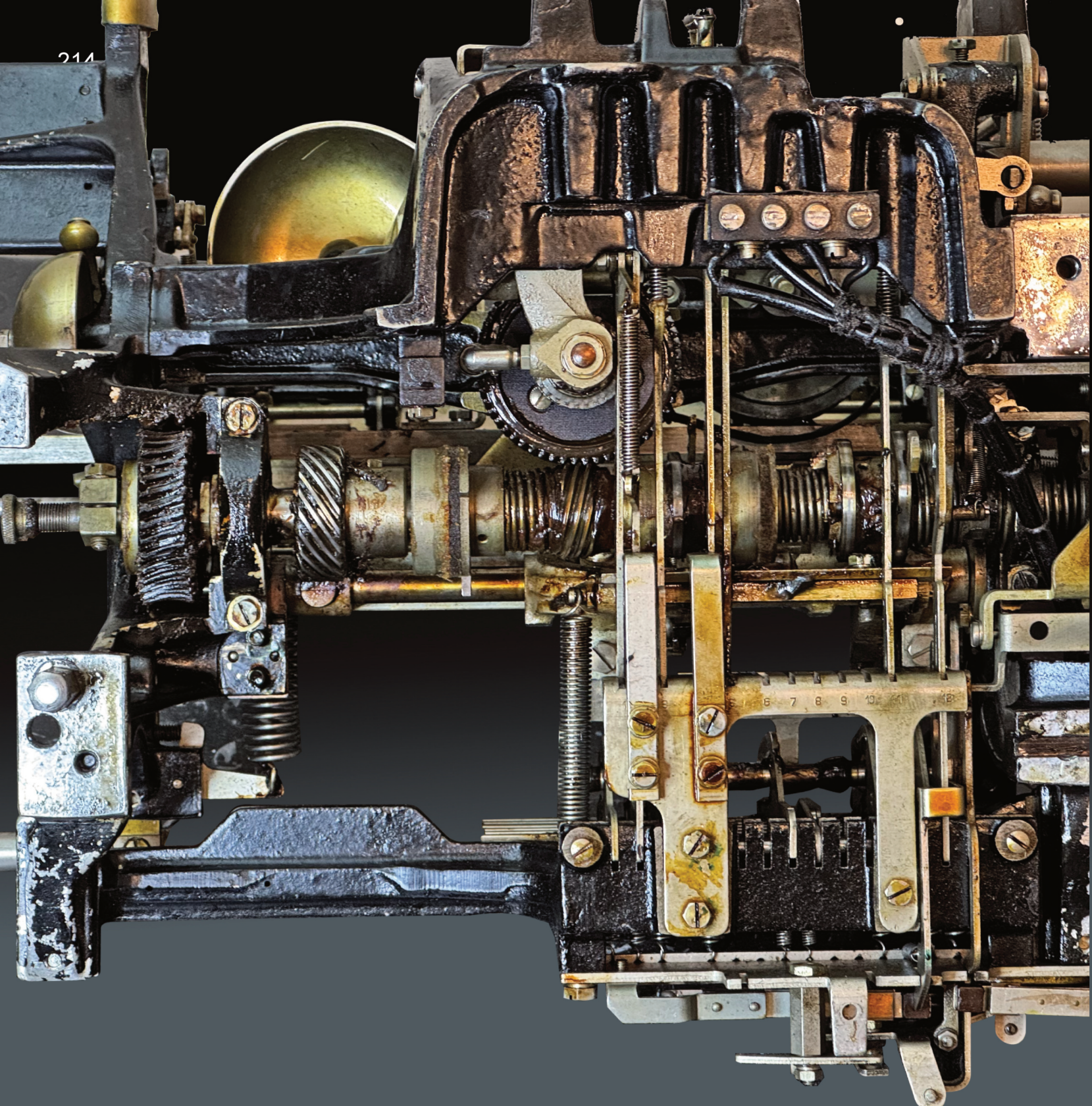




What is much less obvious, if one relies only on the manual, is the relationship between the FIGS and LTRS mechanisms. However, the photograph on the next page, taken from below, removes any doubt. A simple bar, called the SHIFT LINK, connects the LTRS and FIGS PUSH BARS. Whichever push bar is actuated last determines the state of the flip-flop, which is then maintained by the SHIFT DETENT described above.

Although not easy to see, the tail of the LETTERS PUSH BAR — that is, the portion toward the front of the machine — also moves the sixth VANE downward, signaling that the machine is currently in the LTRS state.

Right: the mechanical “flip-flop” where the FIGS/LTRS state is stored. The lever is actuated by either the FIGS or LTRS bar. Above: the LINE FEED function. Also visible is the vertical link that positions the platen for FIGS or LTRS operation.



On the upper side, check the cleanliness and proper operation of the contacts. Also ensure the correct engagement of the front coupling located on the small shaft. Its disengagement can be tested simply by giving the shaft a quick turn by hand.

The bent rod protruding from the front is part of a linkage that enables continuous character repetition when rotated into position.

This feature is quite useful, and its purpose will become clear later.

Reinstalling the keyboard is easy: just insert it in its seat and secure it with the fixing knobs, taking care to ensure proper meshing of the helical gear pair.

Note: some adjustments to the keyboard were necessary in my case; these are described in the related chapter below.



Above: This splendid-looking keyboard is not real, even though it may appear so. It was simply redrawn by me to give an idea of how it looked when new. A 3D model of the keys is currently under development.



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LTRS

LINE
FEED

BLANK

General Cleaning

How to Make it Shine

A thorough cleaning was therefore mandatory. Over time I experimented with several different techniques:

- using a brake cleaner (JMC Bremsen Reiniger A1);
- using a water-based degreaser (I used Chanteclair, a common household detergent);
- a combination of both;
- an ultrasonic cleaner with water and Chanteclair;

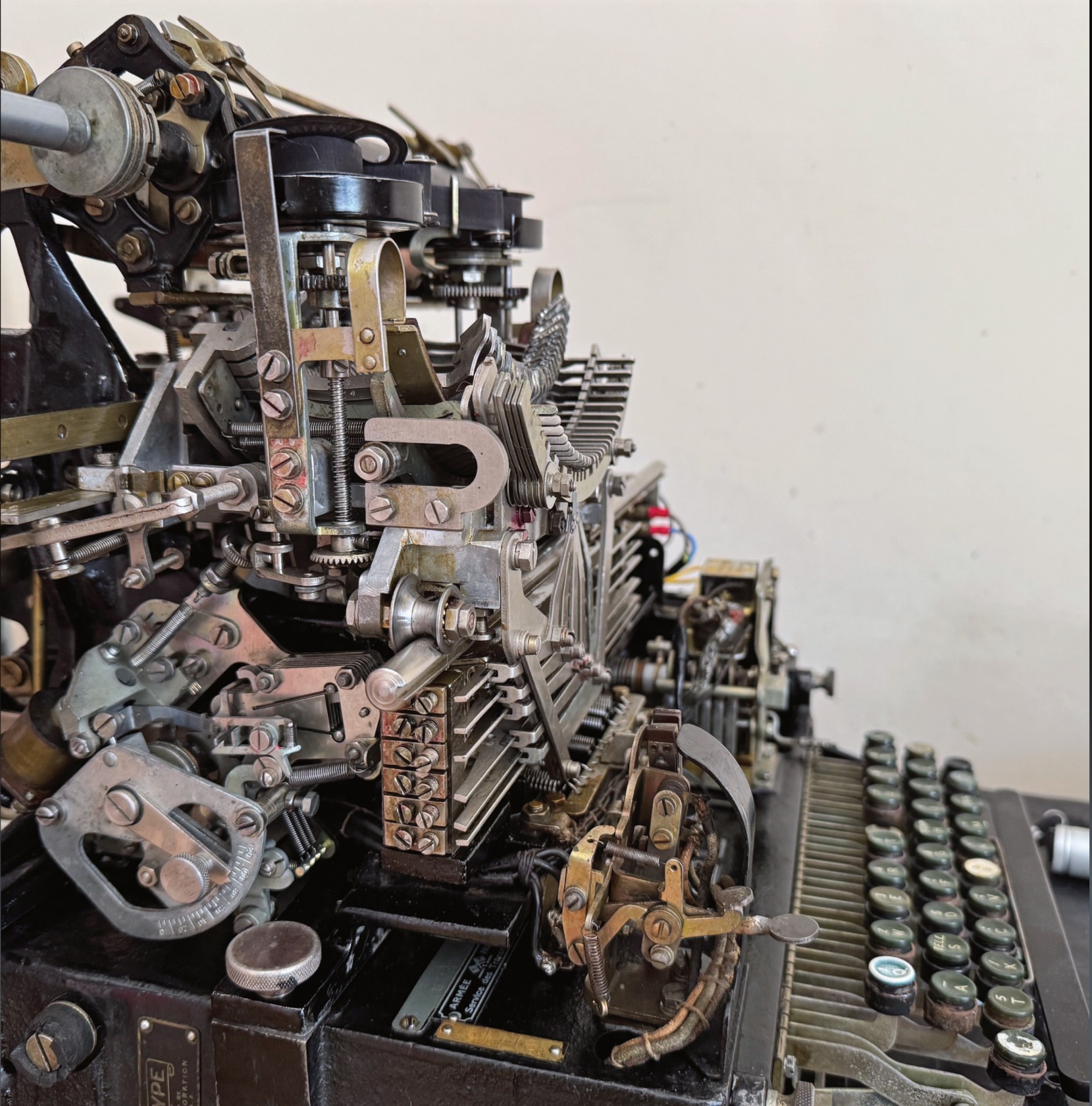
I did not test it, but diesel fuel could possibly be an effective solution.

Each method has its pros and cons. Brake cleaner is very effective and leaves no residue, but it must be used with care and in a well-ventilated area. Water-based degreasers are safer and easier to handle, but they require thorough drying afterward. The ultrasonic cleaner can work well for small parts, although it is not always practical for larger assemblies.

In any case, always dry the parts carefully using plenty of compressed air, and repeat the process if necessary. Finally, it is good practice to keep the parts slightly warm for several hours to eliminate any residual moisture.

None of these methods is perfect. In my case, a complete cleaning eventually required disassembling the selector as well. Most likely, the old grease, once dissolved, spread into areas where it had never been before, effectively turning into a sticky film that behaved more like glue than lubricant.

❶ The ultrasonic cleaner. Many models are available on Amazon; aside from minor details, the main difference is their capacity. I also tested it with electronic boards with good results (a Tektronix 7A18 plug-in is shown in the photo), but with the TG-7 selector assembly it delivered splendid results. ❷ The common household degreaser Chanteclair degreaser works wonderfully on metals, but it is a bit too aggressive for plastics or painted surfaces. ❸ I used the JMC Brake Cleaner A1 for the first time. It leaves surfaces very clean, and I did not notice any residue. ❹ A FIAC air compressor I bought on Amazon is ideal if you work in an apartment, as it is extremely quiet. During use it failed, but Amazon refunded me, and I bought another identical unit. It is a valuable tool for people like me.



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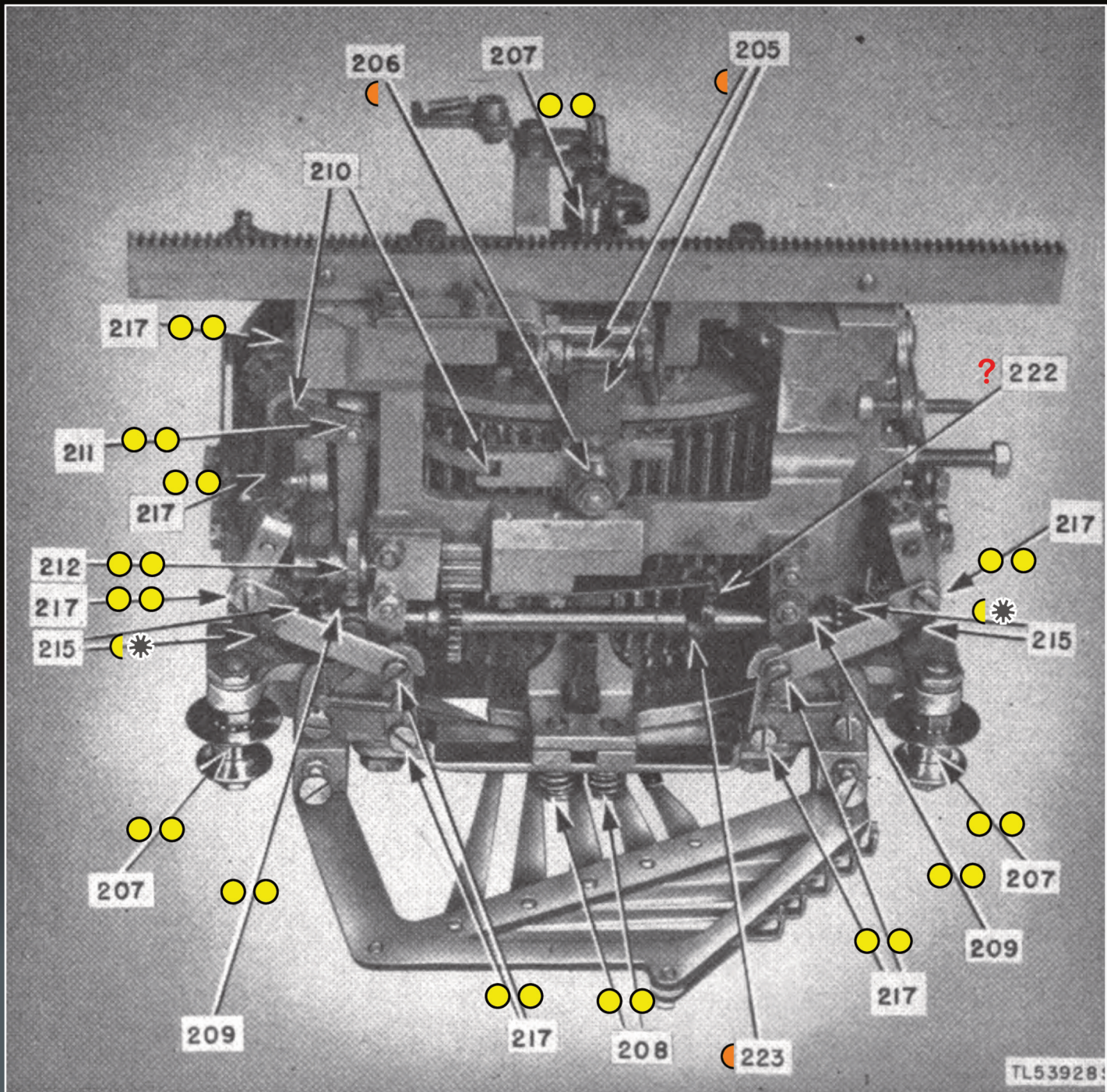
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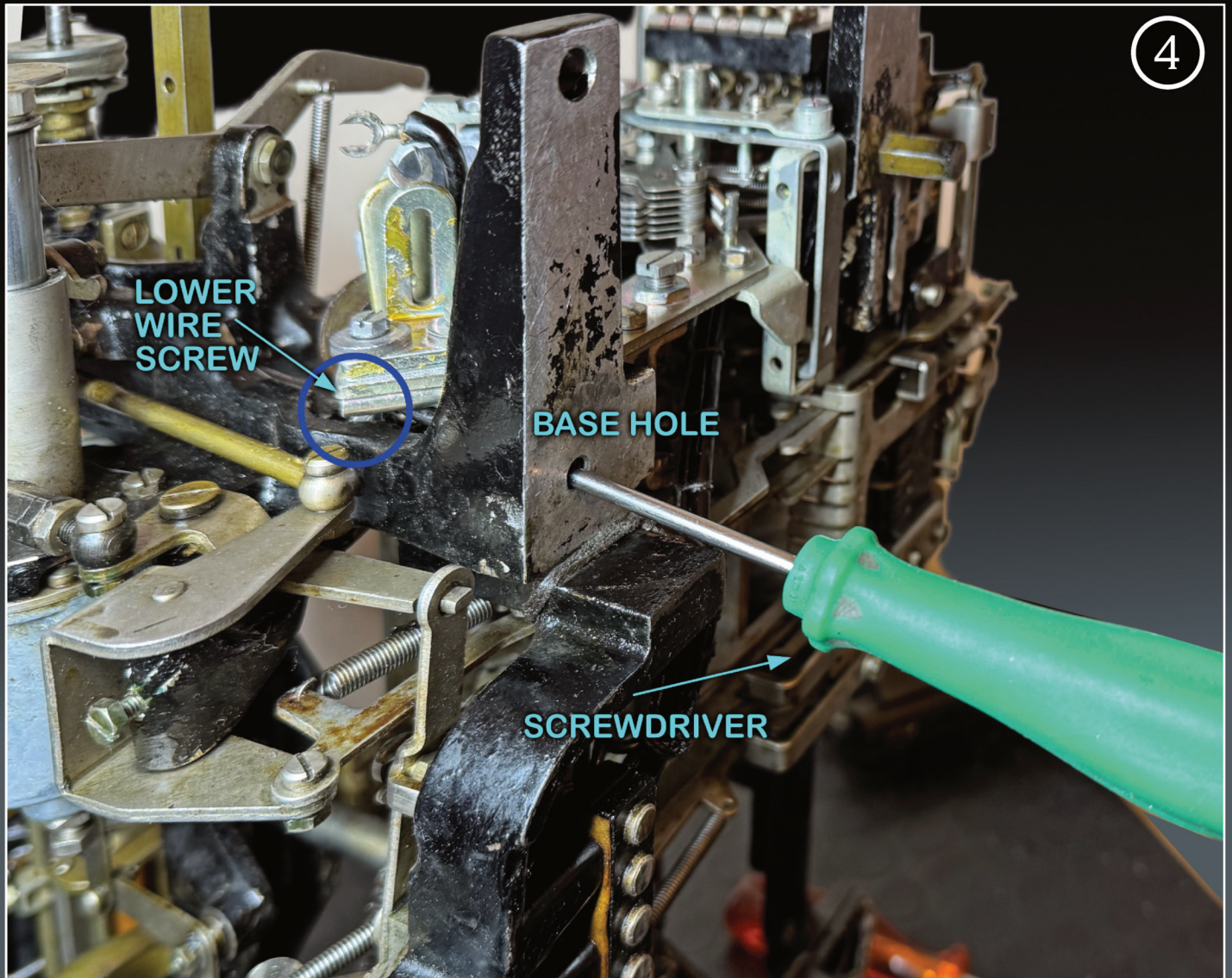
Lubrication Points, Bottom of Type Bar Carriage



- **Extract the coils** – Once the connections are free, remove the screws and extract the coils 259 (photo (2)).
- **Extract the selector** – Remove the three retaining screws circled in red in photo (1). Carefully lift out the selector assembly.

No force should be required at any stage. If something does not move freely, stop and verify that all retaining elements have been properly released.

② Removing the magnet coils. ③ Location for checking the current armature setting before removal — taking a reference photo is strongly recommended. ④ A useful trick for reaching the lower wire screw of the lower coil: access it through the hole provided in the cast-iron base.



Disassembling the Selector

Preparation

Selector disassembly is not particularly difficult, but it requires great care. Prepare a clean workspace and a number of small containers to keep the parts. Remember that losing even a single component may compromise the entire machine.

You will need, above all, a few specific tools:

- a 1/4" open-end wrench
- a 1/4" socket with a screwdriver-type handle

Do not attempt to loosen the screws with a standard screwdriver. They are relatively delicate, and there is a real risk of damaging them.

Removing Other Subassemblies

First, two subassemblies mounted on the selector must be removed:

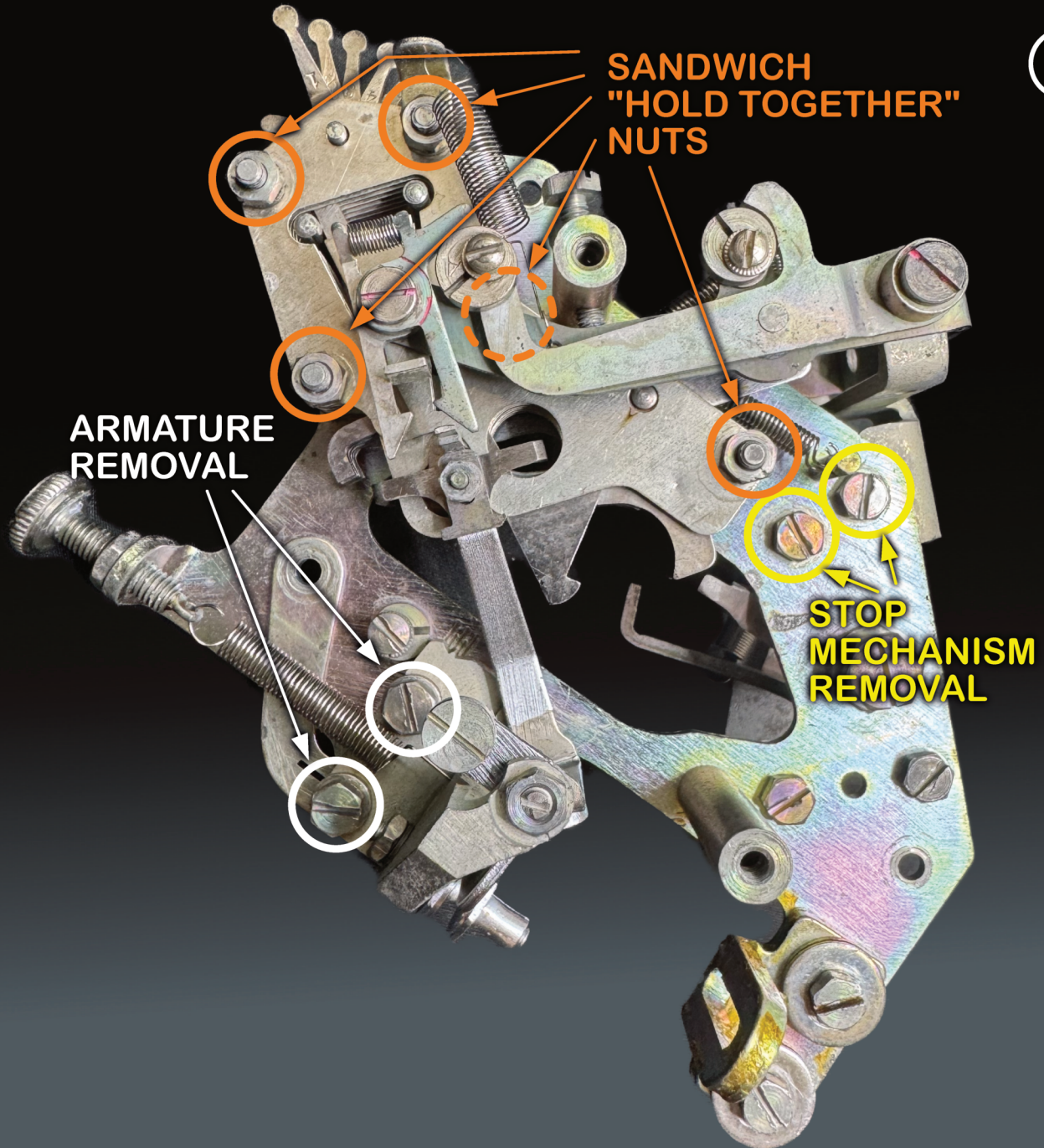
- take a photo of the current armature position (photo (3) above);
- remove the armature by undoing the two screws circled in white in photo (5);
- remove the stop mechanism by undoing the two screws circled in yellow in photo (5), together with its spring.

The next step is to open the “sandwich” (orange nuts in photo (5)). Before proceeding, however, it is a good idea to pause, reorder your workbench, take a coffee — and, above all, carefully read what follows.

The Sandwich

The selector is essentially a layered structure — like a wafer or, if you prefer, a multi-level sandwich made of different kinds of bread, salami, ham, and cheese.

This analogy may sound playful, but it serves a precise purpose: some layers may appear similar, yet they are not interchangeable in all cases. Understanding where each “ingredient” belongs is essential.



Above: the screws used to remove the **ARMATURE** and **STOP MECHANISM** subassemblies. The orange circles indicate the nuts that hold together the “sandwich” forming the selector itself, as described in the text.

Within this assembly, decades of mechanical ingenuity are condensed into a remarkably compact structure.

266 Other Ingredients

Once the “sandwich” is opened, we can examine one level in detail. Here we finally see the SELECTOR LEVERS, the SWORDS, and the T-LEVERS.

Note that:

- the SWORDS are all identical and interchangeable;
- the T-LEVERS are all different, but each is stamped with a number (see photo), so incorrect assembly is unlikely.

At this point, it becomes possible to interact directly with the mechanism and fully understand its operation.

In the photo, note the presence of dirt deposits, which were preventing proper operation. Most likely, this is grease that entered during previous cleaning and later solidified.

Also note that the SWORD should pivot on its hinge together with the SELECTOR LEVER with virtually no resistance when everything is in good condition.

Finally, observe that the central portion of each SEPARATOR PLATE is slightly bent, so that it acts as a leaf spring.

Cleaning

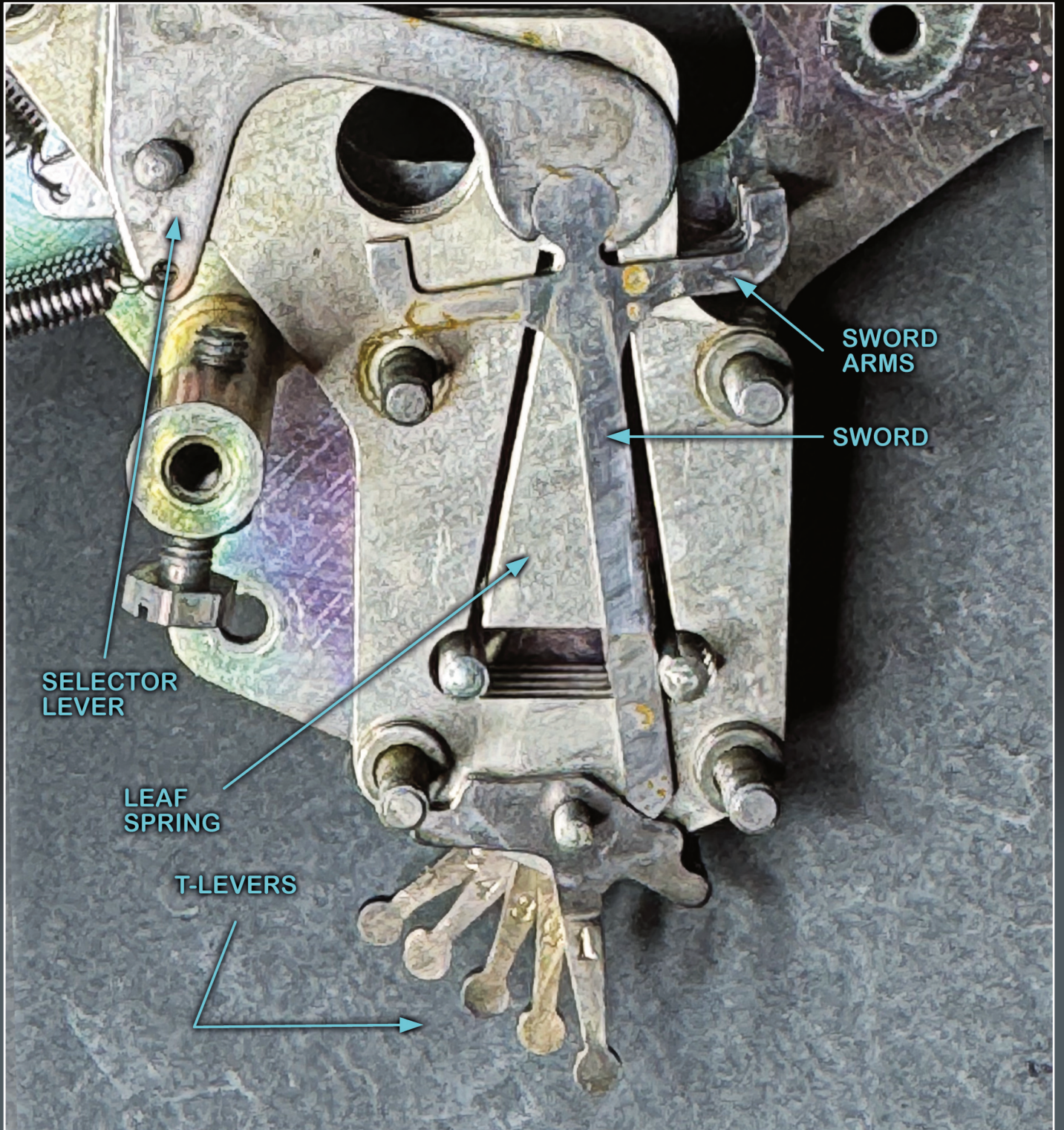
I carefully cleaned each component using a cloth and a metal cleaner before reassembly. All parts were in excellent condition and, once cleaned, appeared almost like new; the SEPARATOR PLATES, in particular, reached an almost mirror-like finish.

Reassembly

With the help of the photographs and the information above, reassembly should not present any particular difficulty. Test the mechanism repeatedly to ensure that everything operates smoothly and correctly.

I did not apply lubrication during reassembly; this will be done later, if required, following the instructions in the manual.

Photo: finally, I was able to observe the actual internal construction of the selector — something I had previously only been able to infer from the low-resolution drawings in the manual. The design is far from trivial. Most likely the result of the ingenuity of Edward Kleinschmidt, it represents the state of the art of the 1930s and 1940s. What is even more remarkable is that this solution proved so effective that it remained in use for many years thereafter.



SELECTOR
LEVER

LEAF
SPRING

T-LEVERS

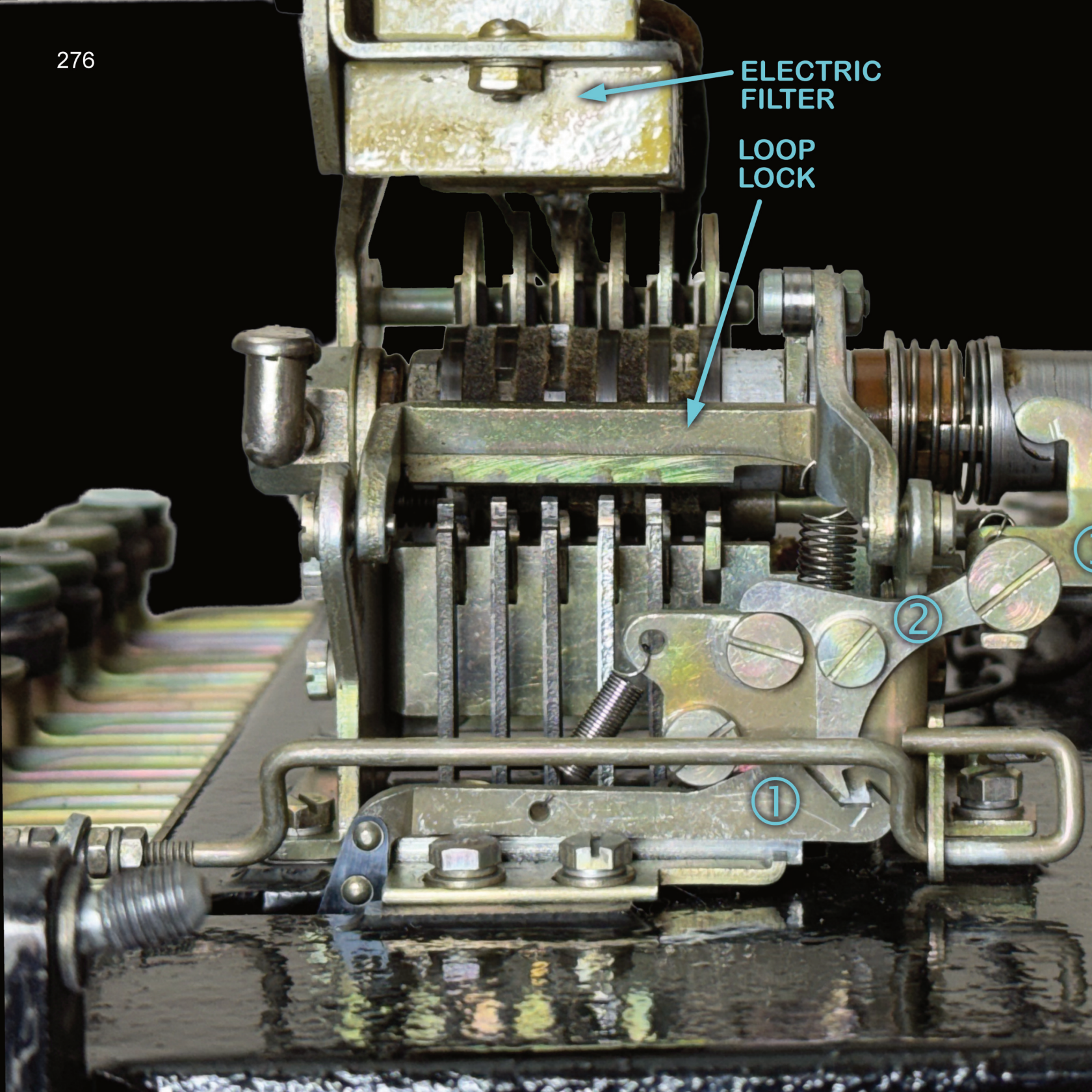
SWORD
ARMS

SWORD

276

ELECTRIC
FILTER

LOOP
LOCK



(4) This image shows two incorrect conditions:

- the clearance between levers (1) and (2) is incorrect;
- eccentric (C) is not positioned with its high side toward the rear, as can also be seen from the marks left on the metal surface.

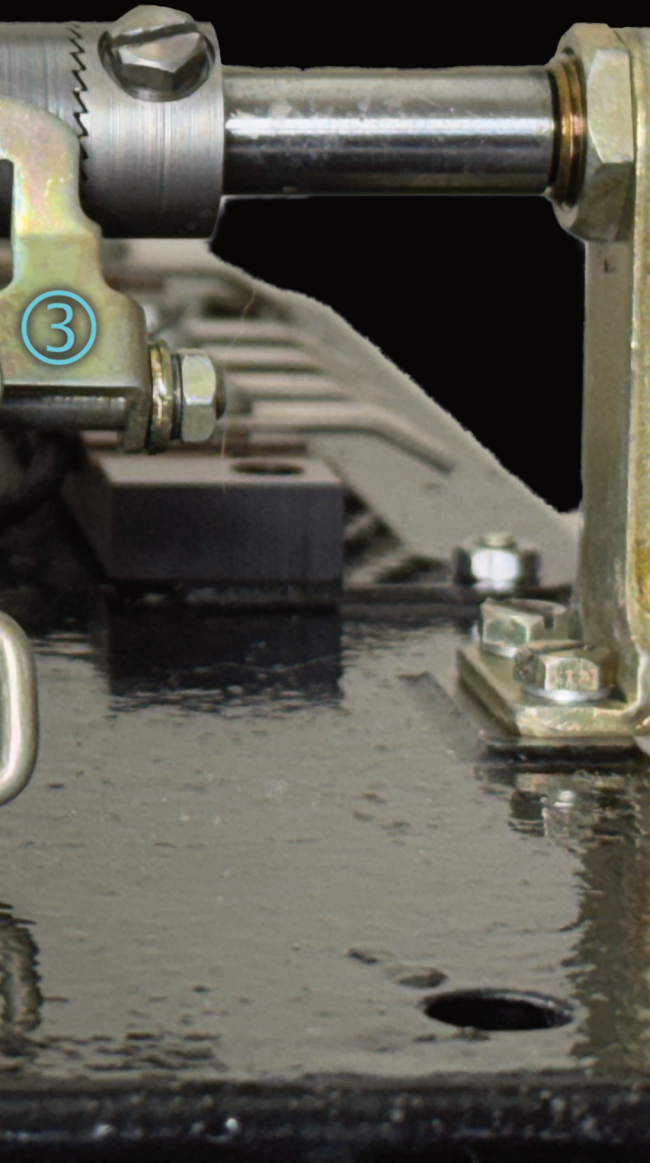
(5) The **UNIVERSAL LEVER**. The required clearance is 1 to 1.5 mm, measured when the **TRIP-OFF PAWL** (lever (1)) is resting against the end of the **PAWL STOP PLATE**.

(6) This perspective view makes the operation of the three levers (1), (2), and (3) easier to understand.

(7) Left: to loosen the locking nut of eccentric (C), it may be necessary to remove the **ELECTRICAL FILTER** and tilt the **LOOP LOCK** lever, as shown in this photograph.

NOTE: To convert the clearances given in inches to millimeters, multiply the value in inches by 25.4. For example: $0.004" \times 25.4 = 0.10$ mm.

- Saved Apr 3, 2026
- Released Apr 3, 2026



Conclusions

I can say without hesitation that my encounter with the TG-7 has been one of the most fascinating and rewarding experiences of all my explorations into vintage equipment.

Working on this machine taught me a lesson that goes far beyond the object itself. Too often we look at technology from the distant past with a certain condescension, as if it had been created by men working with primitive ideas and limited understanding. Nothing could be more mistaken.

The engineers and craftsmen of that era possessed remarkable intelligence, discipline, and practical skill. Without computers, CAD systems, artificial intelligence, numerically controlled machinery, or any of the countless tools on which we now rely, they conceived and built devices of astonishing complexity. In many respects, machines such as the TG-7 were true mechanical computers: intricate, precise, and designed with a level of care that still commands admiration today.

What is even more extraordinary is that they did not merely exist on paper or in theory. They were built in metal, assembled by human hands, placed into service, and made reliable enough to survive the passage of nearly a century. Many of them, against all expectation, are still able to work exactly as their designers intended.

That is no small achievement. It is, rather, a powerful reminder that genuine engineering greatness does not depend on the tools available in a given age, but on the intelligence, imagination, and determination of the people who use them.