Ahlborn und Steinbach

Type S22

An electronic classical organ based on vacuum tubes.

Ahlborn u. Steinbach Type S22 Electronic Organ

From Another World

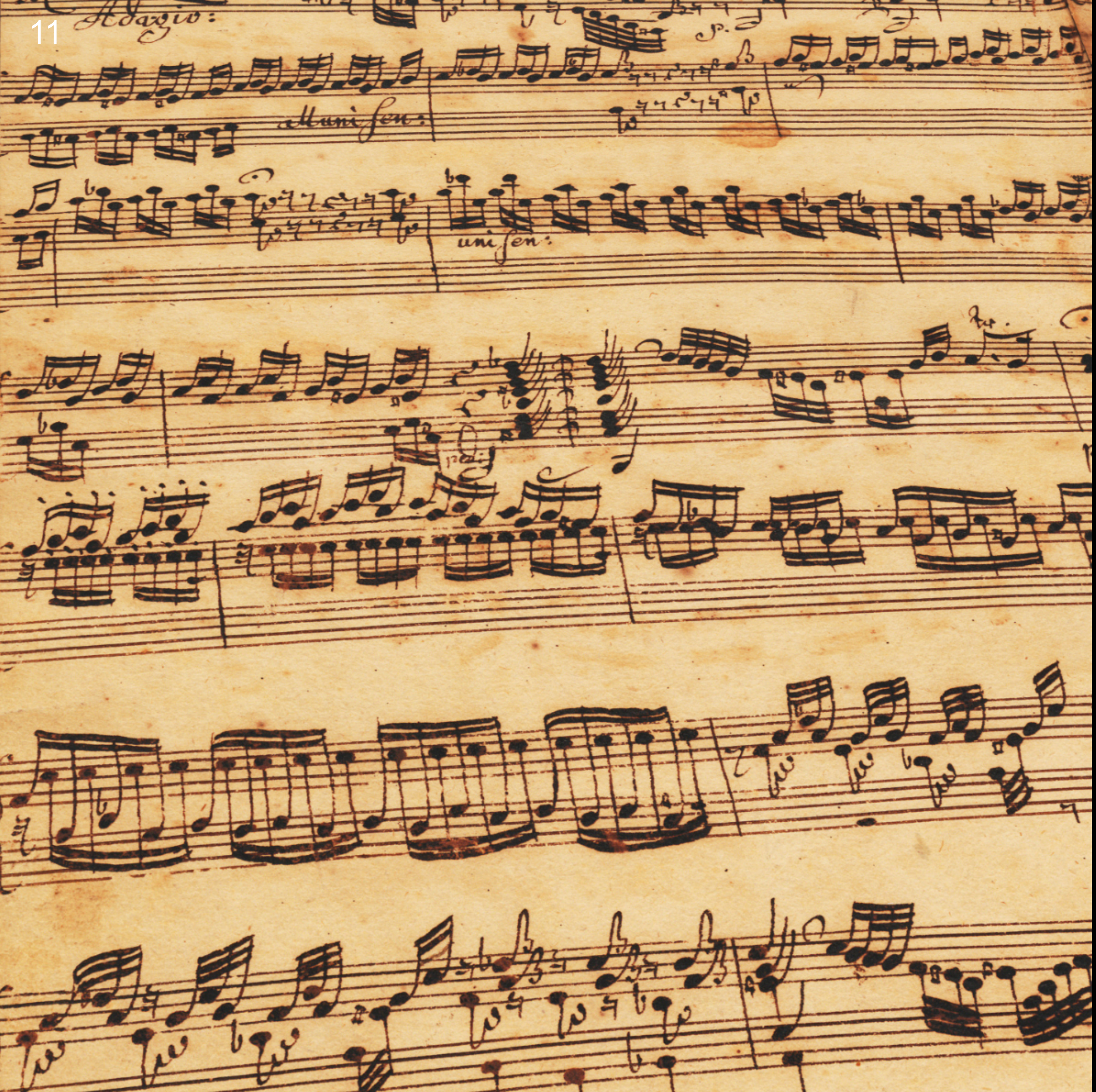
This is a completely different story than the ones we normally talk about. Today, we are not investigating radio equipment, measurement instruments or computers, but a musical instrument and specifically an electronic organ; however, a masterpiece in its class. What excites me the most, is that it is completely tube based: no transistors, no solid-state diodes, no ICs…

The organ we are talking about is a **Type S22**, produced by **Ahlborn u. Steinbach K.G.** in Heimerdingen b. Stuttgart. I presume it was produced between 1955 and 1960, because the company was established in 1970, and in 1960 changed its name simply in Ahlborn.

I Was Younger (a Little…)

This story begins in July 1970; I completed the secondary school, and was going to begin the University, but only in November, so I had complete freedom to pursue my interests.

The years before, I had built a transistorized electronic organ, and was still trying to improve it. At that time, there was a small shop almost in front of the Florence Cathedral, selling and repairing musical instruments. There, a guy named Ermanno was an electronic technician and a victim of mine, because I used to bother him asking suggestions, schematic diagrams or components. On a day in that July, he said me: *"Gianni, you are trying to build an organ… why don't you buy one ready to be used? I might have a good opportunity for you…"*. The opportunity was the organ you can see in these pages; a vacuum-tube organ, coming from the church of a big ship. It was completely different from all the electronic organs I had seen before, and produced a wonderful classic sound, like a pipe organ.



In the same period of time, I was working also on “real” pipe organs, and thus I found that gear terribly attractive. The price was convenient, but I had no idea no idea how to pay for it. My father came to my aid: *“I planned to give you some money for your vacations… if you give up your holidays…”*.

The decision was automatic, and after some efforts to arrange transportation, I became the owner of this wonderful musical instrument.

I tried also to learn music, but the results were not exceptional… My life took a different direction, with electronics prevailing on music, so I gradually remained just a classical music listener. When I got married, we had no room for the organ, and I gave it to the wife of a friend, very clever musician. Over the years, I completely forgot it.

A couple of years ago, I received a phone call: “sorry we cannot keep your organ any longer… do you want to get it back or can we discard it?” Discard? You are mad, I thought, definitely I want it back!

So I discovered that my poor old friend had been abandoned under a canopy and probably never used. It was in very bad conditions; some stop keys had been broken and it had become also a nest of rats. Resisting the temptation to kill my friend and his wife, I organized transportation to my country house with the fundamental help of my friend **Gianni Barsi**, and left it there, waiting I had time for it.

This summer, exactly 53 years after the purchase, I started the restoration process, which lasted exactly one month and that I am going to summarize in these notes.

A Note About the Language

In the field of music, the Italian language is often used, and even the organ here described, albeit built in Germany, has most of the stop labels written in Italian.

In this document, I try to avoid to use musical terms like *Quinta*, *Ottava*, *Duodecima*, *Decimanona* etc. that I find often misleading, but I’ll try to use more engineering terms, speaking mainly of frequencies, so that we can understand each other even without a musical culture.

On the left: from Wikimedia, an old manuscript with the Toccata and Fugue in D minor, BWV 565 of Johan Sebastian Bach, perhaps the most famous piece for organ in the world.

Pipe Organs

To understand my Type S22, it is necessary to understand, with the aid of **Wikipedia**, some basic principles of a **pipe organ**.

The **pipe organ** is a musical instrument that produces sound by driving pressurized air (called wind) through the organ pipes selected from a keyboard. Because each pipe produces a single pitch, the pipes are provided in sets called **ranks**, each of which has a common timbre, volume, and construction throughout the keyboard compass. Most organs have many ranks of pipes of differing pitch, timbre, and volume that the player can employ singly or in combination through the use of controls called **stops**. (in Italian *Registri*)

A pipe organ has one or more keyboards (called **manuals**) played by the hands, and a pedal clavier played by the feet; each keyboard controls its own division (group of stops). The keyboard(s), pedalboard, and stops are housed in the organ's console. The organ's continuous supply of wind allows it to sustain notes for as long as the corresponding keys are pressed, unlike the piano and harpsichord whose sound begins to dissipate immediately after a key is depressed.

I like to think that the magic of the organ is **dissonance**. The ranks are not “aligned” each other. Octaves can be “shifted”; for example, the same key can produce C1 with a rank of pipes, C2, C3 etc. with other ranks, and more ranges can be active at the some time, so that a single key produces C1 and C3 together.

Nevertheless, not all organ stops play an octave above or below, but there are some that play an octave and a fifth above (Twelfth, *Duodecima*), two octaves and a third above (Twelve-seventh, *Decimasettima*), three octaves and a fifth above (Twenty-sixth) and so on. These mutation stops therefore emit a note that does not correspond, in the different octaves, to the one played, but will therefore emit harmonics, of which the most common are those in the fifth, but some in the third are also found.

But why this dissonance does not produce a striking effect? It is the wise balance of these different tones that creates the typical celestial sound of the organ, mixing tones in various harmonics even before Jean Baptieste Fourier investigated his mathematical series.

Dissonance?

I found the answer to my doubt about the dissonance in the organ's sound in an old book, still used by organ students, written in the end of the nineteenth century by Enrico Bossi and Giovanni Tebaldini, from which I report an extract. Its Italian sounds rather obsolete now, and this makes it even more interesting. The English translation follows.

"Non deve far sorgere alcuna obiezione il fatto che un accordo dato dal ripieno dell'organo, per i risultati armonici accennati, abbia a generare una cacofonia prodotta dal cozzo dei diversi suoni risultanti da ogni nota che a primo esame potrebbero sembrare appartenenti ad una diversa base tonale. Sta appunto nel giusto equilibrio dell' intonazione, nel suono dolce che devono produrre i diversi registri per natura, e nella proporzione esatta del numero dei registri di base colla quantità dei registri di mutazione, che deve risultare quell'effetto grave, solenne, maestoso ed assolutamente armonioso che, come si disse più addietro, è proprietà assoluta degli organi italiani, specialmente degli Antegnati e dei Serassi."

[No objection should arise from the fact that a chord given by the filling of the organ, due to the harmonic results mentioned, should generate a cacophony produced by the clash of the different sounds resulting from each note which at first glance might seem to belong to a different tonal base. It lies precisely in the correct balance of intonation, in the sweet sound that the different registers must produce by nature, and in the exact proportion of the number of basic registers with the quantity of mutation registers, which must produce that grave, solemn, majestic and absolutely harmonious effect which, as was said earlier, is the absolute property of Italian organs, especially of the Antegnati and Serassi.]

Praeludium II

AHLBORN ORGELN

Ahlborn-Orgel is a company founded as **Ahlborn und Steinbach K.G.** in 1955 in Heimerdingen, a district of Ditzingen in the district of Ludwigsburg in Baden-Württemberg. Since its founding, it has specialized in the manufacture of electronic and digital keyboard instruments.

Since 1960, the company has been run as **Ahlborn-Orgel** GmbH. The company still produces and sells electronic and digital organs for the liturgical sector, for churches and cemetery chapels, but also organs for the entertainment sector.

When it was founded, the company initially moved into the former Heimerdingen schoolhouse on Hindenburgstrasse. The company was later relocated to the newly developed industrial area in Heimerdingen. In the early 1970s, the company was managed by Klaus Beisbarth as managing director, the engineer Otto Riegg as technical director, the cantor Josef Michel as artistic director, Heinz Heindel as head of light music and Prince Karl Anton von Hohenzollern.

In the photo, current **Praeludium II** model, which is presumably the last heir of the Type S22, obviously based on modern technology. The resemblance with its grandfather is however clear.

A Vacuum-Tube Organ

Traditional Electronic Organs

I suppose that nowadays electronic organs might be based on sound synthesis, but all the organs I knew were based on the same logic: twelve oscillators, one for each note, produce the topmost octave (BTW, notes are not seven, as we use to say, but twelve, including semi-tones).

For each note, an array of flip-flops is used to produce the lower octaves, thanks to the fact that octaves differs from the one above, exactly for **half-frequency**. For example, DO6 (C6) has a frequency of 1046.5 Hz, DO5 523.251 Hz, DO4 261.626 Hz, and so on.

Obviously, flip-flops, built with transistors or ICs, produce digital signals, and thus square waves, but a square wave, with its high content of harmonics, is a good base from which derive different timbres rather easily.

Type S22 Principles of Operation

At first sight, Type S22 principles of operation seem to similar to those depicted above, but they aren't. I could not find any information about it, and I had to decode its way of operation by mean of a full reverse engineering, whose result you find in the following.

Like other electronic organs, the S22 has **12 oscillators** for the topmost octave as well, but it is based on sinusoidal waves only: the topmost oscillator produce a sinewave and the subsequent dividers are not digital, but **analog**: a tank circuit, based on an inductor and a capacitor, is progressively tuned to the lower octave, as we are going to see more in detail later. The result is that no square wave is used, but only sine waves, from DO1 (C1) at 32.7 Hz to SI8 (B8) at 7902 Hz. Each note is so available is 8 frequencies, and every possible sound is obtained wisely mixing them together, in a way rather similar to classical pipe organs.

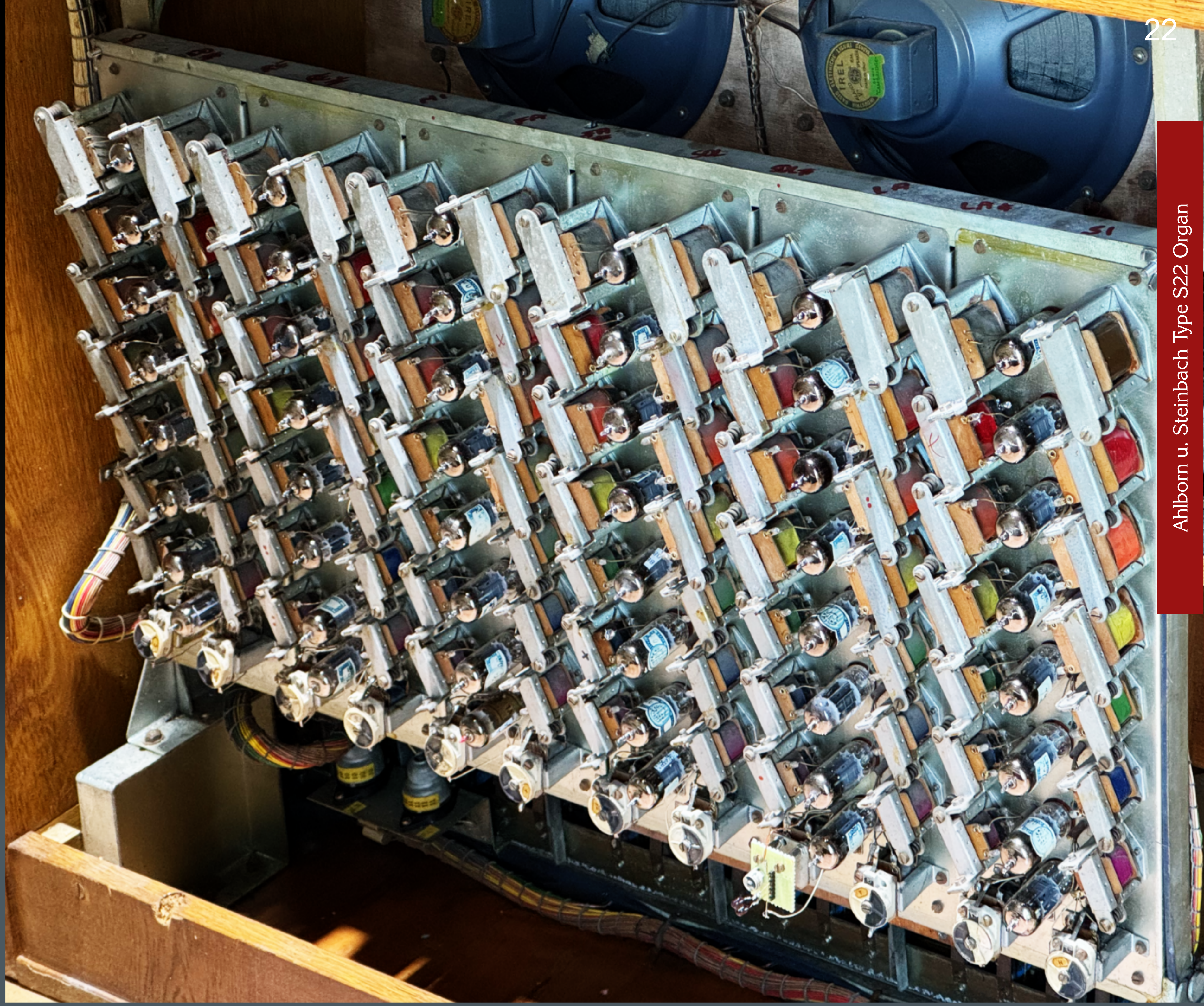
Just Like a Resistor

A relevant step forward in the S22's investigation was when I understood that frequencies or, better, octaves of frequencies, are **coded after the colors**, exactly like resistors (brown = 1, red = 2, orange = 3 etc.). That is rather evident if you look at the picture here on the right, but simply… when I started the restoration, everything was too dirty to note the colors.

The **table** below reports the frequency, in Hertz, for each note of each octave. The oscillators generate grey frequencies, and the dividers all the others. The table indicates also note names and their alternate nomenclature used in English-speaking regions. Note that the above octave has always twice the frequency of the one below.

In the big photo on the right, the Frequency Generators Array, with the color coded inductors.
Below, the notes frequency table.
Here on the right, the "plate" with the manufacturer's name, the model and the serial number..

	1	2	3	4	5	6	7	8
	BROWN	RED	ORANGE	YELLOW	GREEN	BLUE	PURPLE	GREY
DO (C)	32.70	65.41	130.81	261.63	523.25	1046.50	2093.00	4186.01
DO# (C#)	34.65	69.30	138.59	277.18	554.37	1108.73	2217.46	4434.92
RE (D)	36.71	73.42	146.83	293.66	587.33	1174.66	2349.32	4698.64
RE# (D#)	38.89	77.78	155.56	311.13	622.25	1244.51	2489.02	4978.03
MI (E)	41.20	82.41	164.81	329.63	659.26	1318.51	2637.02	5274.04
FA (F)	43.65	87.31	174.61	349.23	698.46	1396.91	2793.83	5587.65
FA# (F#)	46.25	92.50	185.00	369.99	739.99	1479.98	2959.96	5919.91
SOL (G)	49.00	98.00	196.00	392.00	783.99	1567.98	3135.96	6271.93
SOL# (G#)	51.91	103.83	207.65	415.30	830.61	1661.22	3322.44	6644.88
LA (A)	55.00	110.00	220.00	440.00	880.00	1760.00	3520.00	7040.00
LA# (A#)	58.27	116.54	233.08	466.16	932.33	1864.66	3729.31	7458.62
SI (B)	61.74	123.47	246.94	493.88	987.77	1975.53	3951.07	7902.13



Switches

Key Switches

Each key (manual or pedal) has 9 **bars** which extend all over the keys: 61 for the manuals and 32 for the pedalboard. Each key has 9 **wire-spring switches**, which close to relative bar when the key is pressed; pressing a key, you activate all the 9 switches, as you can easily understand from the photo here on the right.

Stop Switches

The 9 bars go to the **stop unit**. Each **stop** switch has so 9 signals available to be combined to produce the effective output sound.

Key Switches Map

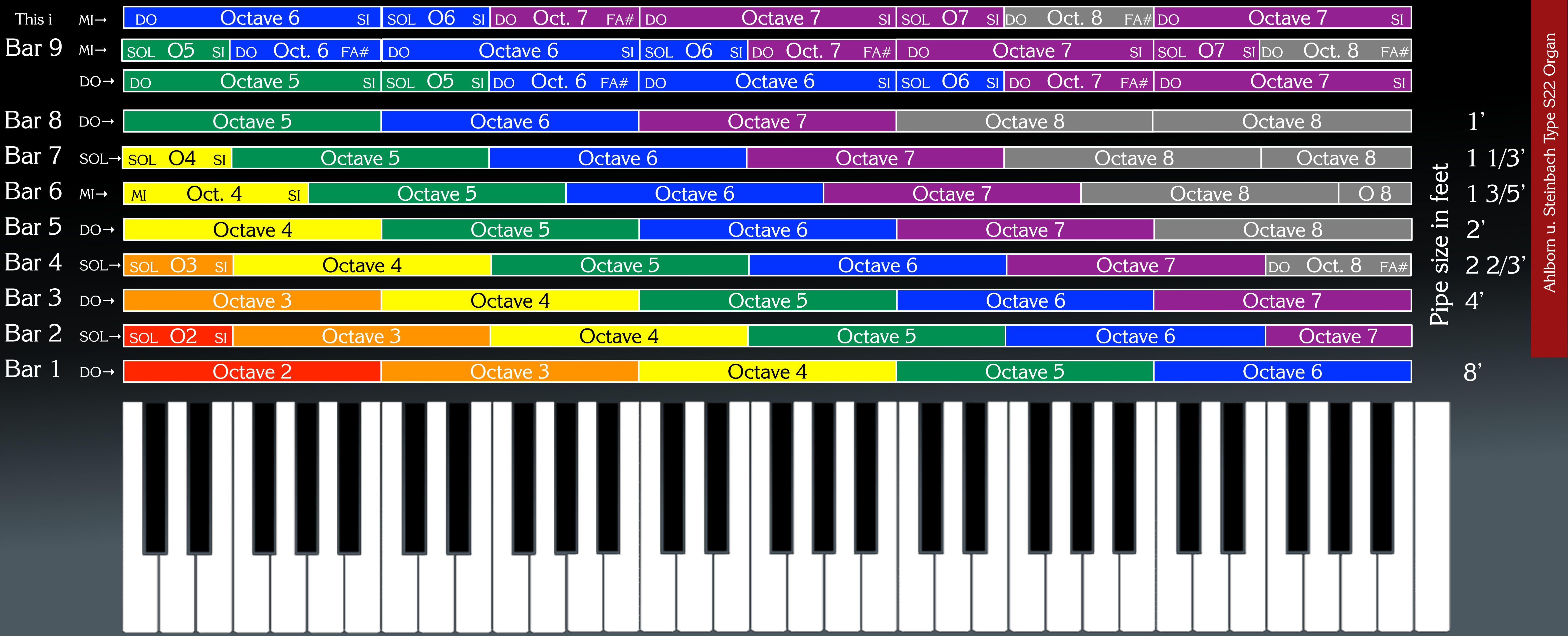
Each keyboard switch is hardwired with a fixed signal from the frequency generators. On the next page, you can find a **map** that shows you where each of the switches is connected in the upper manual (the lower is a little different, for example it has also the 16' signals from the lowest octave, but the concept is the same). Rebuilding this table was not a trivial task.

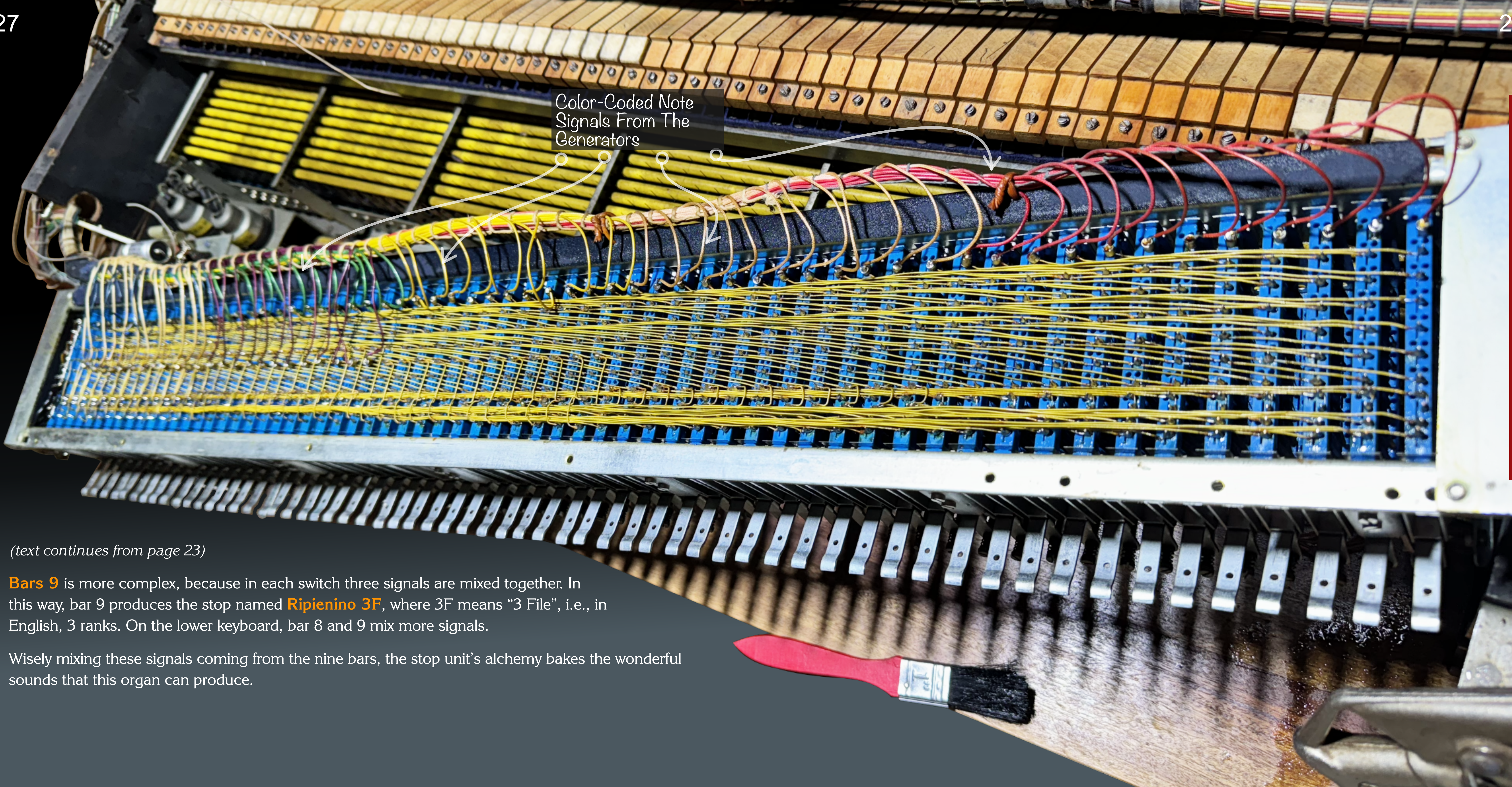
The Bars

I arbitrary assigned a number from 1 to 9 to each of the nine bars.

- **Bars 1, 3, 5 and 8** - As shown in the map, bars 1, 3, 5 and 8 are straightforward: they simply carry the fundamental octaves, progressively shifted toward the left; in a pipe organ, they should be the 8, 4, 2 and 1 feet tall pipes, respectively.
- **Bars 2, 3 and 7** shift the signals not by an entire octave, but start with a SOL (G) note instead of a DO (C). This means that when you press a DO (C) key, you really get a SOL (G) on these bars, that the stop unit can use to produce the desired sound.
- **Bar 6** follows the same logic, but the shift is smaller: when you press the key, you get a MI (E) instead of a DO (C). *(text continues on page 27)*

Upper Manual





(text continues from page 23)

Bars 9 is more complex, because in each switch three signals are mixed together. In this way, bar 9 produces the stop named **Ripienino 3F**, where 3F means “3 File”, i.e., in English, 3 ranks. On the lower keyboard, bar 8 and 9 mix more signals.

Wisely mixing these signals coming from the nine bars, the stop unit’s alchemy bakes the wonderful sounds that this organ can produce.

Stops (not for buses)

Classical Organs

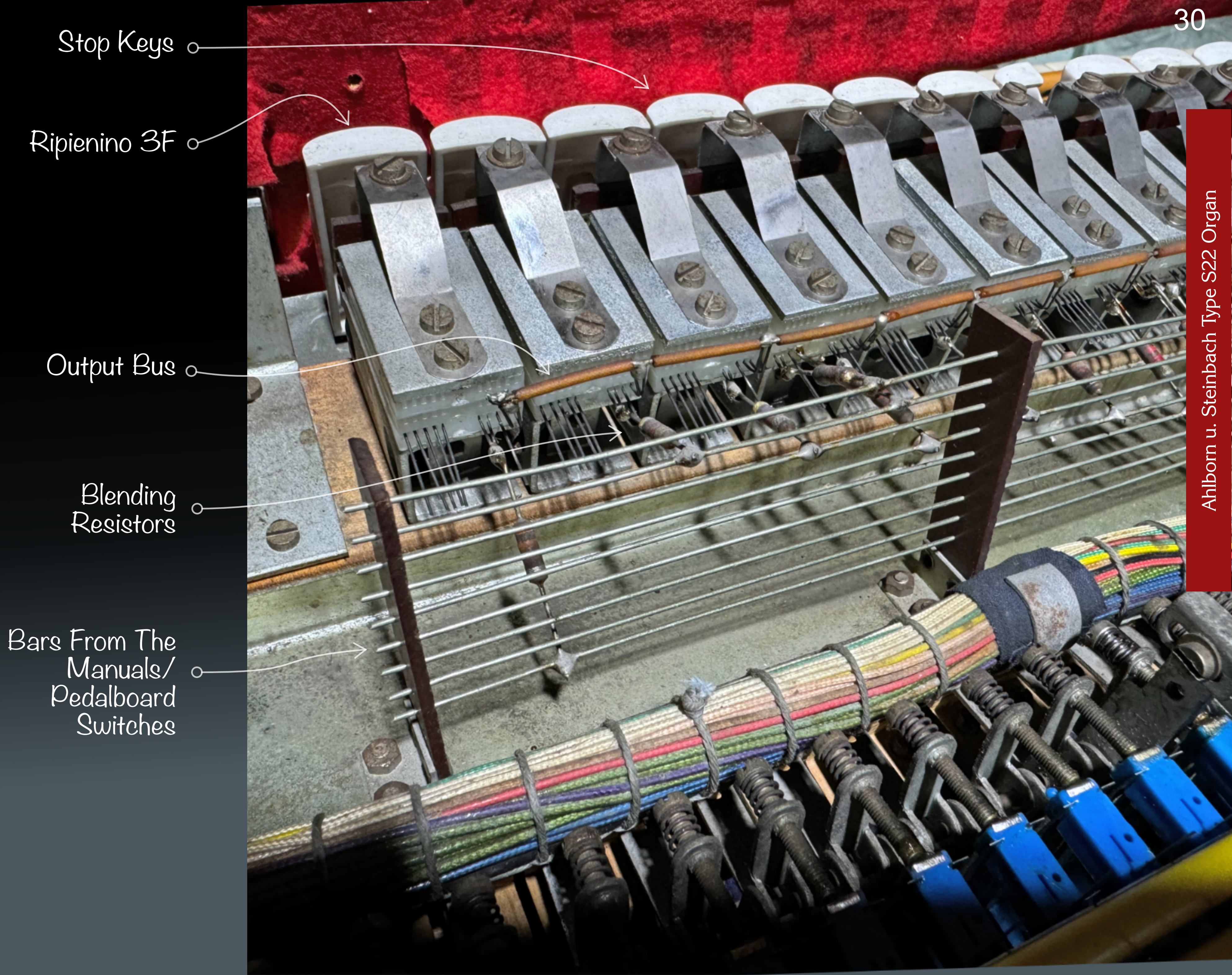
In the pipes organ, stops are used to connect a **rank** of pipes to a manual or pedalboard. You can find a universe of knowledge about pipes and stops. When I worked on them, I could meet the last member of a family of organ builders, who had a craft shop in Campi Bisenzio, near to Florence, selling soaps and other items for housekeeping. He told me that he learnt to build pipes when still a children, and how it was important to properly beat the lead with the hammer, to transform it into slabs suitable for pipe building.

Stops in the S22

As mentioned, Type S22 operates in a way more similar to pipe organs than modern electronic organs, and stops simply combine the signals coming from the 9 bars to produce the output sounds: two sounds for the upper and lower manuals and one for the pedalboard (they will be mixed later).

Each stop is a switch with more inputs and one output. Simplest stops are made with just one resistor, like that of the first three switches on the left of the photo on the right; more complex ones can pick signal from more bars to obtain the desired sound. For example, the upper manual **Ripienino 3F** stop switch just takes a signal from bar 9.

Defining the correct resistors' values was the art of someone whom we will never know, but I can ensure that he or she did a wonderful work.



Ahlborn u. Steinbach Type S22 Organ

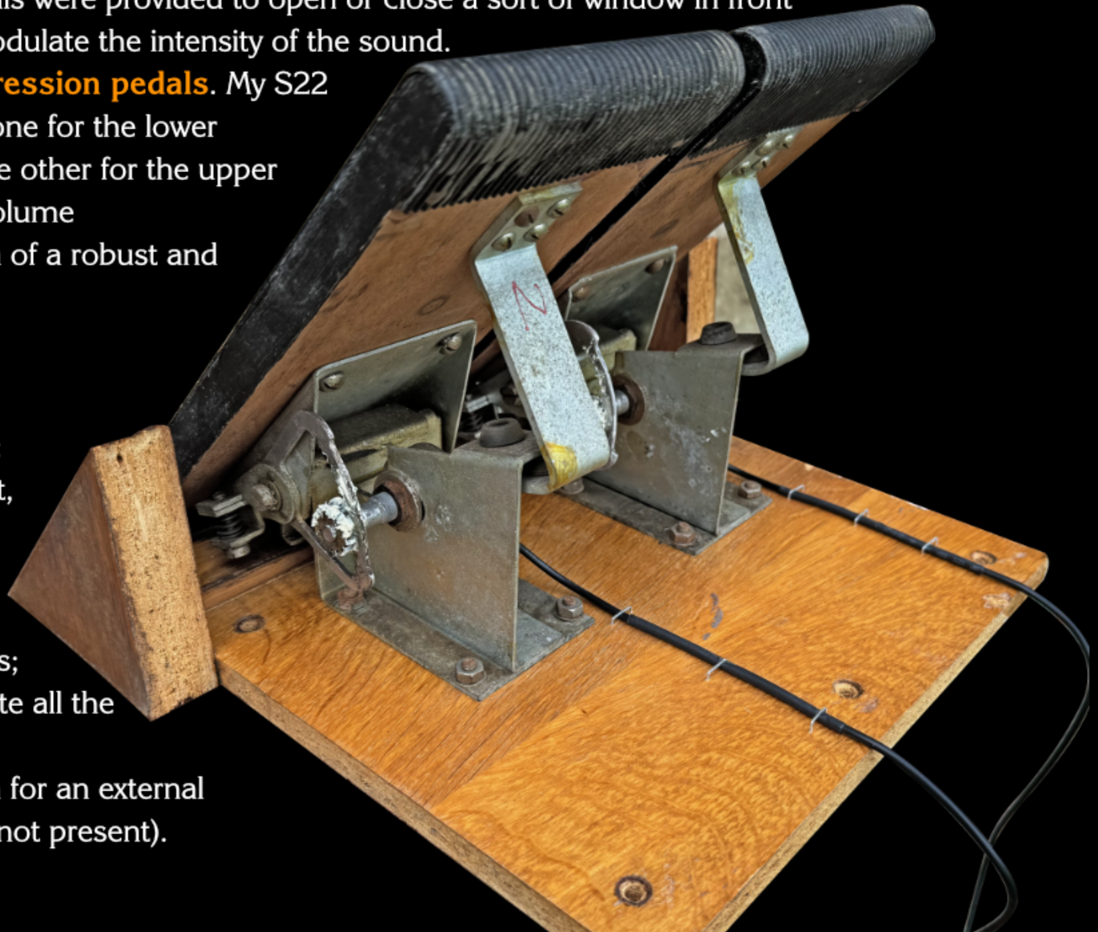
More About Stops

In the facing page, you can see the 31 S22's stops for the upper and lower manuals and for the pedal. Each of them is labeled with the **stop name** and the simulated **pipe length** in feet. The sound effect is very realistic for most of them.

As normal, the pedalboard acts the lowest notes. I suppose that this use was due also to the fact that those big pipes consumed more wind and that a stronger valve was required for them. Before organ evolution, perhaps it was not practical to activate them just with the strength of a finger.

Expression Pedals

In the classic organ, other pedals were provided to open or close a sort of window in front of some groups of ranks, to modulate the intensity of the sound. These pedals were named **expression pedals**. My S22 has expression pedals as well, one for the lower manual and the pedalboard, the other for the upper manual. They simply make a volume potentiometer to turn, by mean of a robust and well built mechanism.



General Stops

Three more stops are provided:

- **Tremolo**, which adds a light, 7-Hz amplitude modulation. Something that later was going to be named Vibrato in more modern instruments;
- **Tutti** - a single key to activate all the stops at the same time;
- **Eco Organo** - the provision for an external accessory producing echo (not present).

Upper Manual Stops

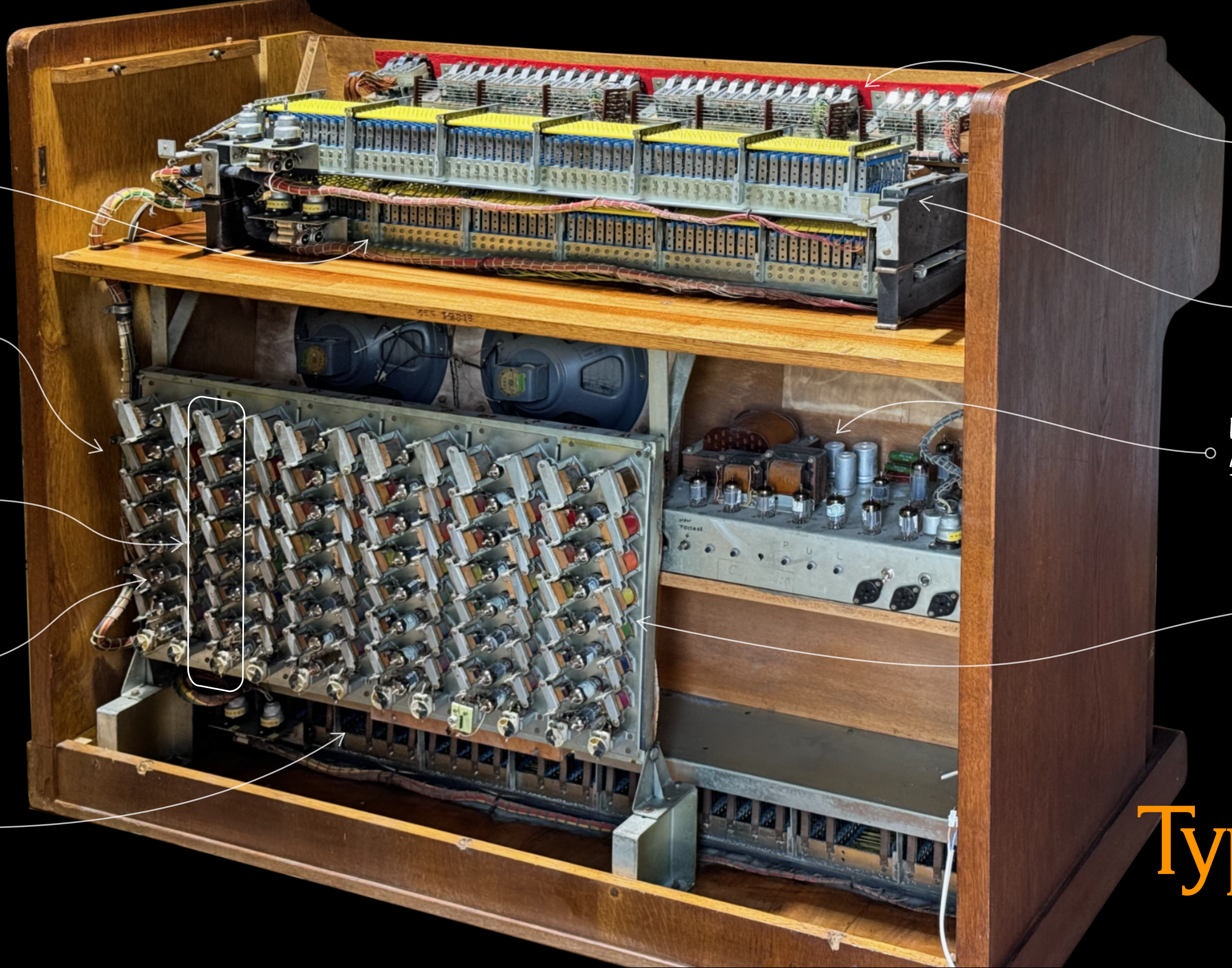
Lower Manual Stops

Pedalboard Stops

S22's stops for the upper manual, lower manual and pedalboard.

Who designed the S22 decided to follow a typical Italian scheme, with the majestic Ripieno 5F, which, in a real organ, would be composed by 5 ranks of pipes.

General Stops


Lower Manual Bars/Switches Assembly
Frequency Generators Array
Each Column is One of the 8 Generators Which Serve one Note
48 x ECC82 Dual-Triode Tubes Each of Them Serves Two Notes
Pedalboard Switch Array
Stops Switches and Mixer Bars
Upper Manual Bars/Switches Assembly
Power Supply, Amplifier and Tremolo Generator
Color-Coded Note Inductors/ Transformers (for Dividers)

Type S22

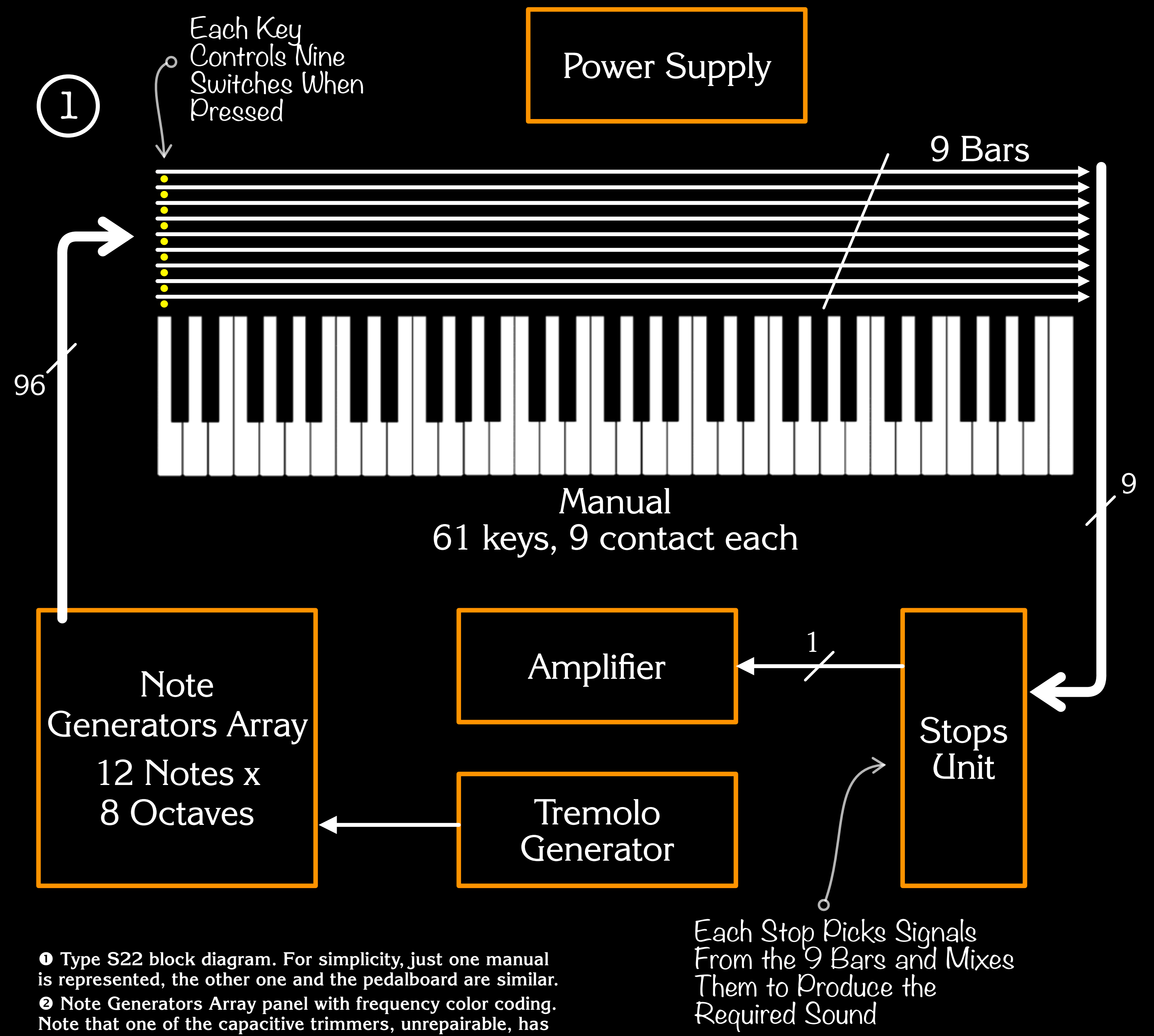
Block Diagram

It's time to create now a **block diagram** for this old musical instrument, resuming what we already described.

Let's start with the image ❷ below, which represents the **Note Generator Array** (NGA) panel. In the lower part of it, you can see the twelve **oscillators** which produce the highest octave, color coded in grey. Each oscillator has a capacitive trimmer to tune it to the right frequency. Above and upwards in the photo, the seven **dividers** which produce the lower octaves. Each horizontal row produces an octave, i.e., 12 notes, on 12 wires.

Moving on to diagram ❶, you can see the NGA with its 96 outputs. Each of them is led to one or more of the **key switches**, according to the diagram on page 25. When a key is pressed, the nine signals assigned to that key are connected to the respective **bar**. The nine bars are fed to the **stop unit**, which can "fish" signals from the nine bars, according the active stops, blending them according the corresponding "recipe".

Auxiliary blocks are the **Power Supply**, the **Power Amplifier** and the **Tremolo Generator**, which we are going to describe with some further detail in the following pages.



❶ Type S22 block diagram. For simplicity, just one manual is represented, the other one and the pedalboard are similar.

❷ Note Generators Array panel with frequency color coding. Note that one of the capacitive trimmers, unrepairable, has been replaced by a temporary PCB stamp.

The Circuit

Simple Circuits for Stunning Results

Used to restore Tektronix or Hewlett Packard instruments, I could not expect from a musical instrument company a comparable technology level. I believe that Ahlborn und Steinbach did however a very good work, using simple circuits at their best, and getting high quality results by a wise and balanced combination of them. Furthermore, to make these circuits simple as possible, was mandatory, in a piece of equipment where these little bricks are used more and more times.

Oscillator

Note master oscillators (figure ❶) are a light variant of the typical Hartley scheme, with a 20-100 pF capacitive trimmer to adjust the note frequency. In this variant, the oscillator allows to control the amplitude of the produced note by mean of a modification of the grid potential. The purpose is supposedly to control the output level with just a single trimmer for all, to equalize the output to the dividers level.

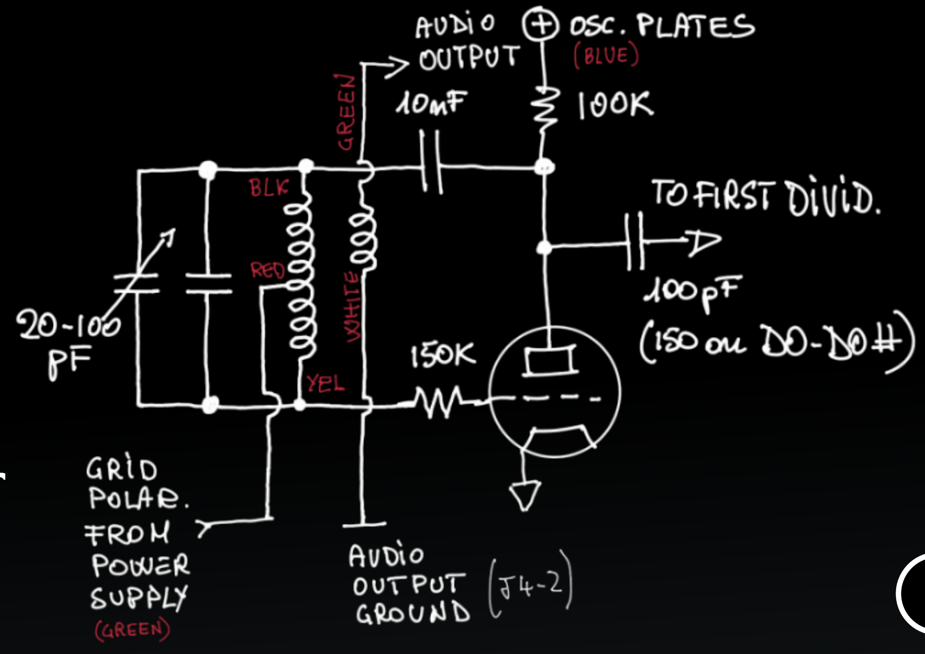
Only two resistors are used. Most of the resistors in this S22 kept, over the years, almost the same value, except few; among them, these oscillators' plate resistors, which increased their values up to 100%, probably because dissipate more heat than the others.

The output signal is taken from a secondary winding on the inductor/transformer, and has a separate ground, while the signal to the subsequent stage (1.st divider) is taken directly from the plate bye mean of a small capacitor. All these capacitors had to be replaced like all the others of the Eroid brand.

Divider

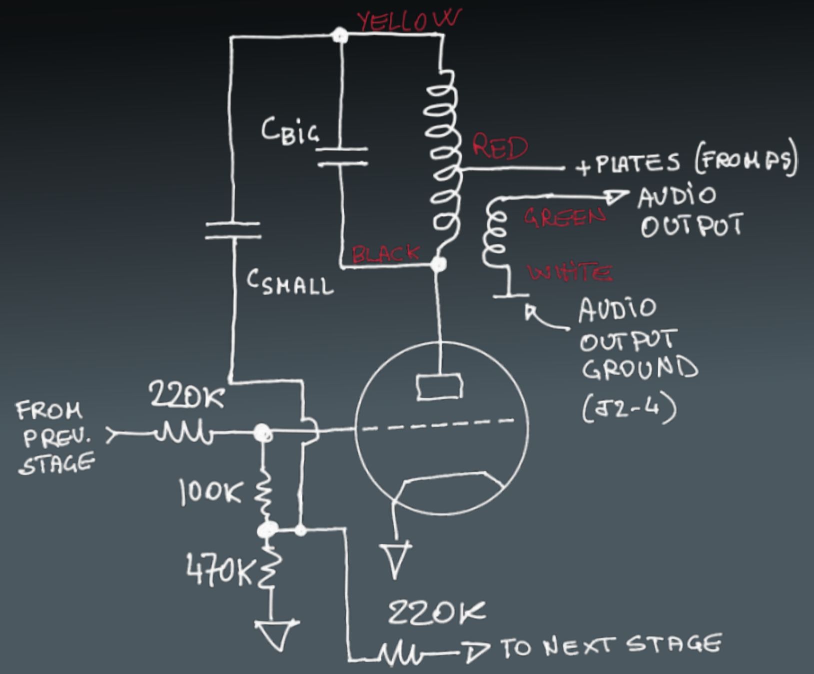
Dividers, shown in figure ❷, are identical each other but with different component values, as we could expect, with bigger inductors for lower frequencies. This circuit also seems to be derived from the Hartley one, but resonates on half frequency of the driving signal. Also in this case, the audio output is obtained with a secondary winding, as seen for the oscillator.

Note
Master
Oscillator



①

Note
Divider



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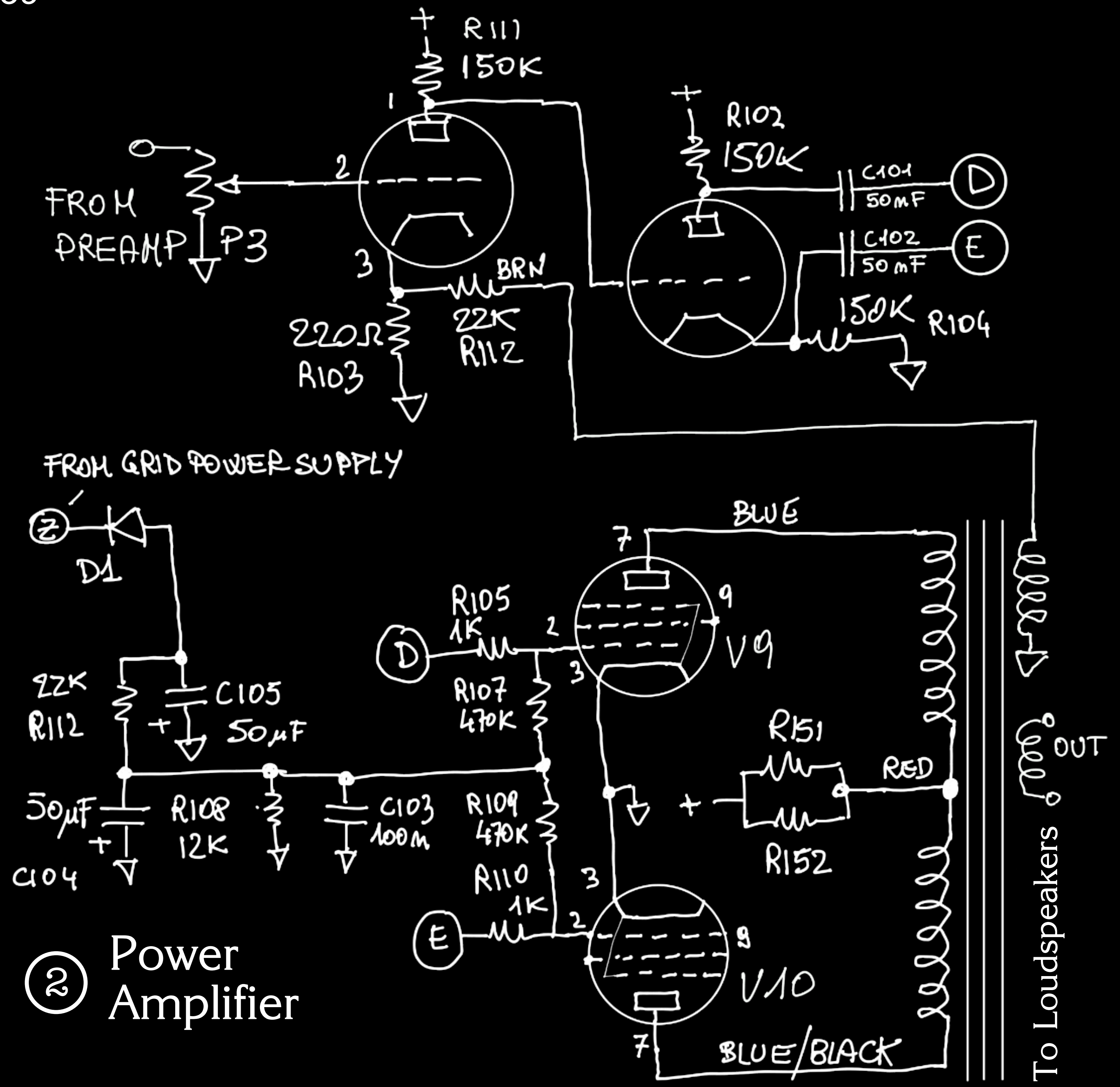


② Power Amplifier

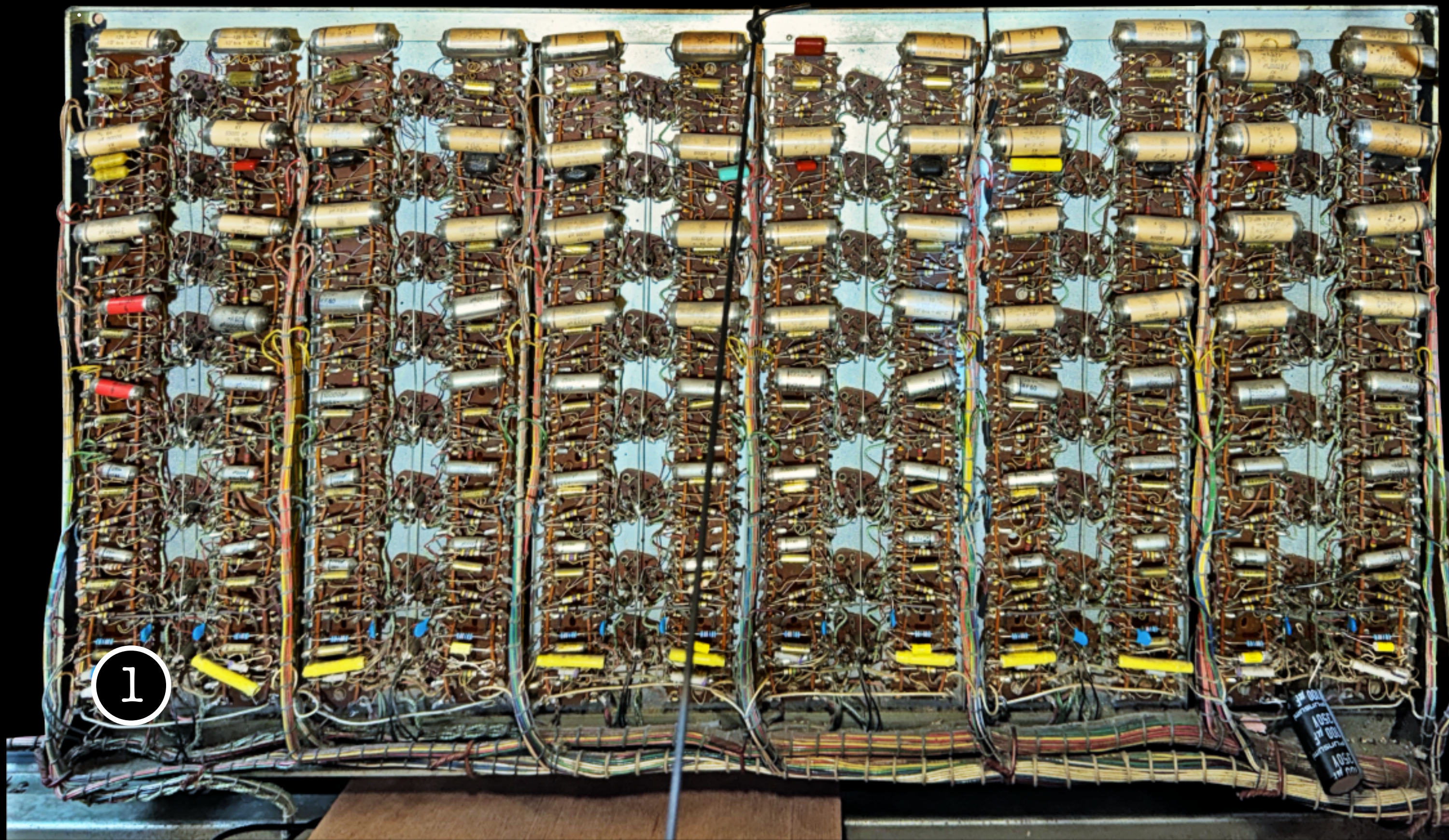
Construction

The NGA is built on a single metal frame which can be tilted for accessing its circuit side (photo ❶). The construction technique is rather classical for the time. Each tube, a dual triode, serves two notes, one assembled on the left and the other on the right of it.

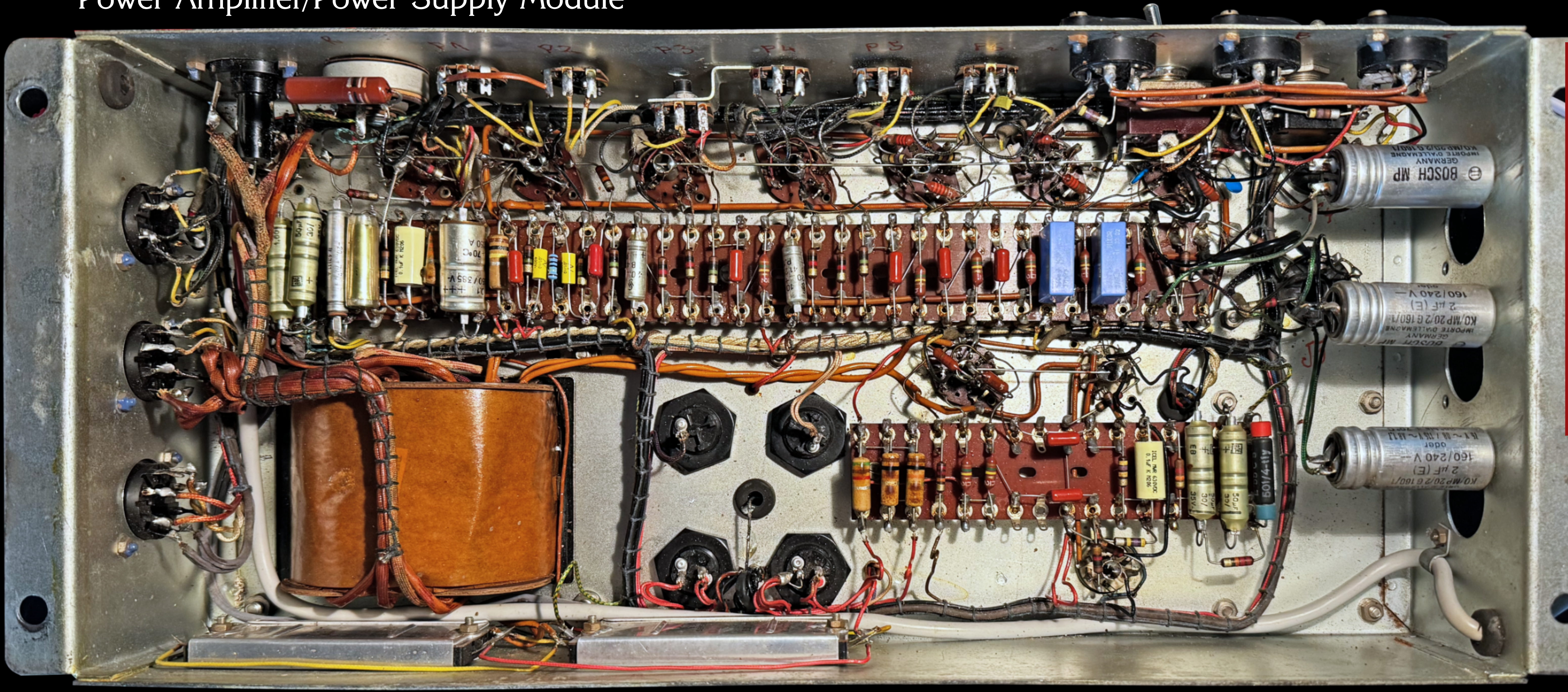
Power Amplifier

The Power Amplifier (PA) is contained in the same module as the Power Supply, and follows a scheme rather classic in the Tubes Age, with a push-pull of EL84, power tetrode, capable of approximately 10W output. Interesting the use of a supplementary secondary winding on the transformer, which in some books is named “tertiary”, for the amplifier feedback. In those years, most radio, TV and turntables rarely had a luxury push-pull amplifier, reaching only 2-5 W of power.

❶ **The Note Generators Array seen from below.**
❷ **Power Amplifier schematic diagram.**



Power Amplifier/Power Supply Module



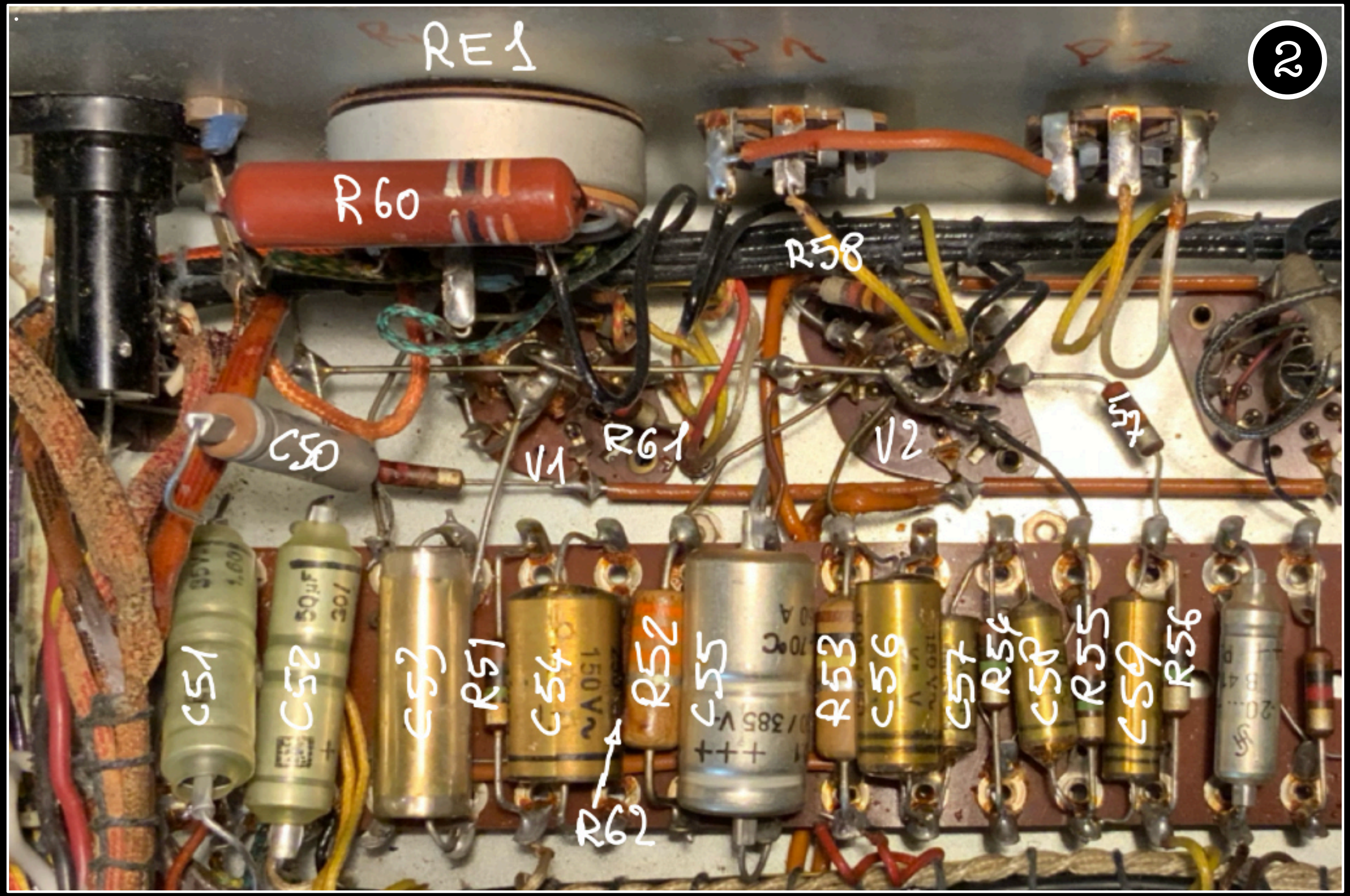
Most of the capacitors in this photo have been replaced (but not electrolytic ones).

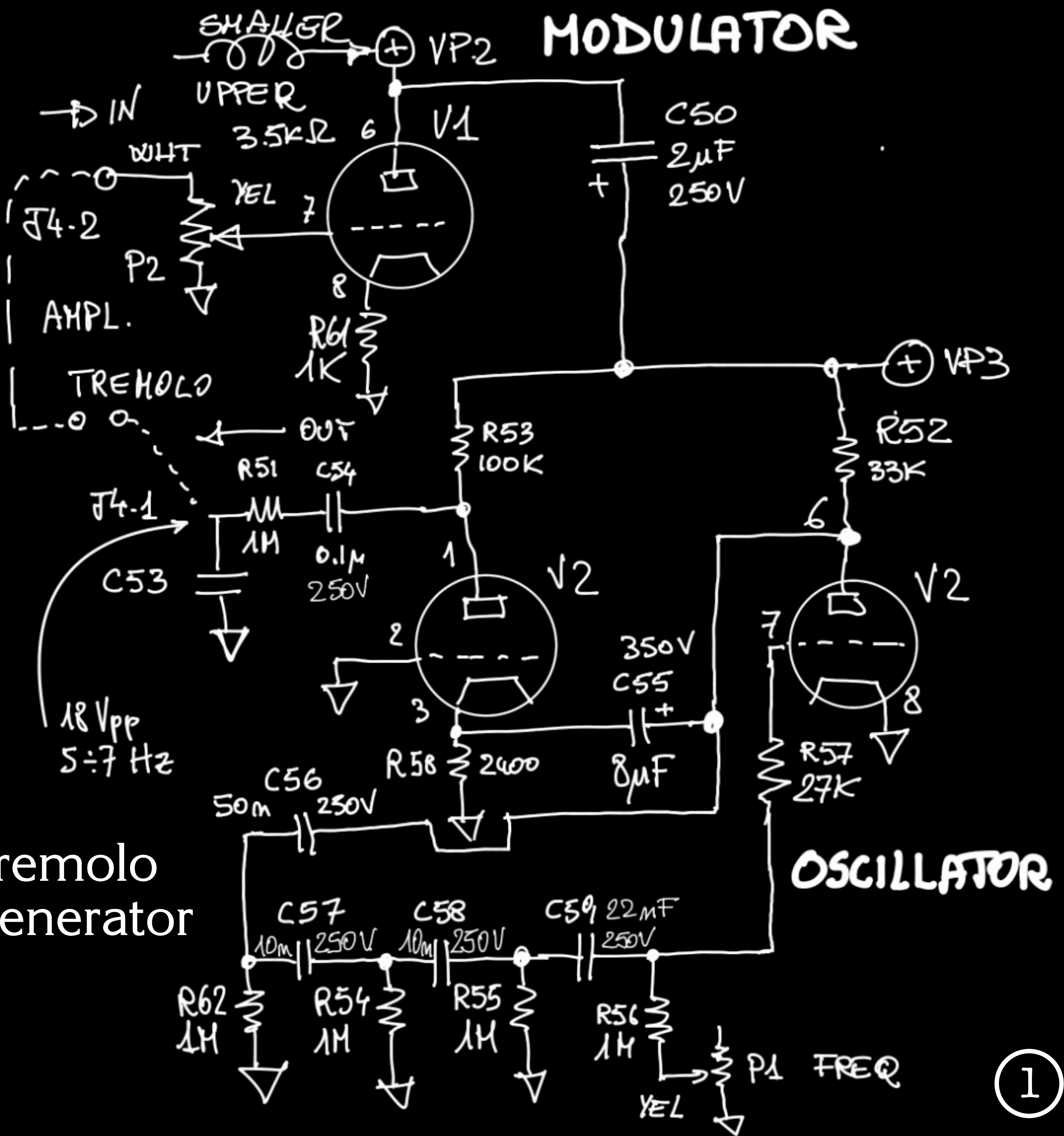
Tremolo

The Tremolo effect is generated by mean of a simple RC Phase Shift Oscillator, whose frequency can be adjusted from 5 to 7 Hz about, When a switch is closed. a corresponding modulate load is produced on the power supply. As many as three triodes have been dedicated to this function.

Also in this case, the effect is very nice and "moderate".

❶ Tremolo Generator schematic diagram.
❷ Tremolo Generator component layout. The big rheostat marked RE1 is the one that allows to change the grid polarization of all the oscillators, to equalize their output to the dividers.





Tremolo Generator

Restoration

A Long and Complex Work

For the bad conservation, the initial condition of this poor organ was not properly “mint”. When I started to work, I was not sure that the repair was possible, fearing at most the mechanics of the keyboards/pedalboard and their contacts, which in reality gave few problem; nevertheless required much time for their high number (154 x 9 contacts = 1386!).

I had to repeatedly “invent” on the fly solutions for several problems that arose from time to time, not only of electronic “favor”, but of many kinds, becoming cleaning man, carpenter, mechanic, etc. and get in some way strange materials.

Several times I've been on the verge of giving up (especially for the inductor problem which I will describe), but eventually the organ is alive again and in rather good conditions. I still have to complete some finishing touches of the wooden furniture, and build the bench, which originally lacked and that I rebuilt at the time, but which is no longer here.

The restoration process required more than one month and about 300 hours, including the reverse engineering and the schematic diagrams drawing.

Special Problems

I was not used to work without any manual, which normally I have with Tektronix, Hewlett Packard or other professional instruments. I could not find any information about this online, so I had to completely reverse engineer this electronic monument.

But for me the worst part of this job was the working position. Simply, I could not put it on the workbench, and had to organize myself to work on all fours…

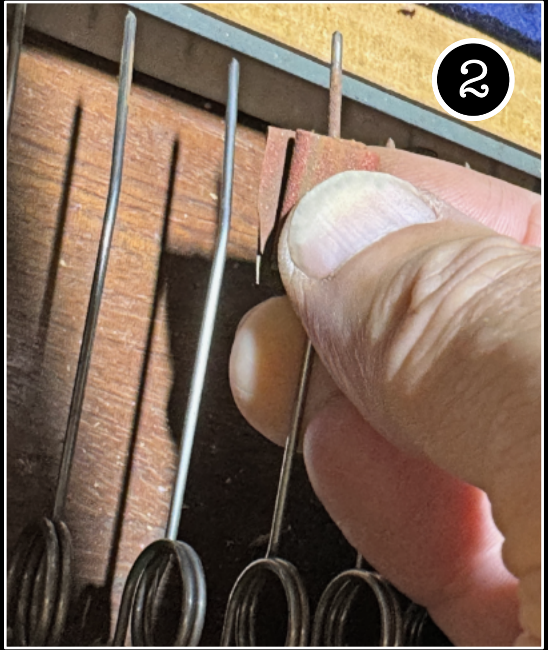
Keys & Mice

Obviously, the first part was just cleaning. As I noted, also a rat built its nest inside it, but he or she was polite enough, and did not produce big damages (or simply had no time for doing that).

My first concern was the mechanical condition; many keys were locked and I feared I could not repair them. But the original quality of the materials was very high, and so I could eventually succeed, but I had to dismount and revise every single key.

The only damage that the mouse produced was to rip off those small red tissue washers under the keys (figure ❸), to use them as materials for its nest. I cannot understand how it did… I had to buy two round punchers to produce the new washers, and the tissue I used was a red velvet ribbon for Christmas presents.

Each key had to be revised, because its mounting hole became a little too small (figure ❶), and also the springs had to be scratched one by one with sandpaper to eliminate the rust (figure ❷). But finally I could get two mechanically perfect, working manuals.



❶ Keys' mounting holes are garnished in velvet, but the velvet become a little thicker over the years, and I had to find a simple process to restore the hole's right size.
❷ Each spring had to be sandpapered.
❸ The first octave of keys has been restored and put in place! Note that each key is numbered.

Contacts & Bars

Contacts

The second step was to recover the contact boards. The switch is composed by a thin spring **iron wire** that the keys press against a bar. The **bar** is in plastic material, with a groove where another small iron bar is inserted. It is not easy to work on the contact boards, because they are permanently tied to mainframe with bunch of wires. However, I could remove all the bars and proceed to a deep cleaning of everything, using my preferred cleaner, the magic Chanteclair. Again, the original good quality helped me: no oxidation was present in the contact points, and so the day come when also the contact boards could be considered in order.

❶ The upper manual contact board, with all the bars removed. One of them is simply placed on top of it.
❷ The initial conditions of one of the contact boards (pedalboard, in this case).

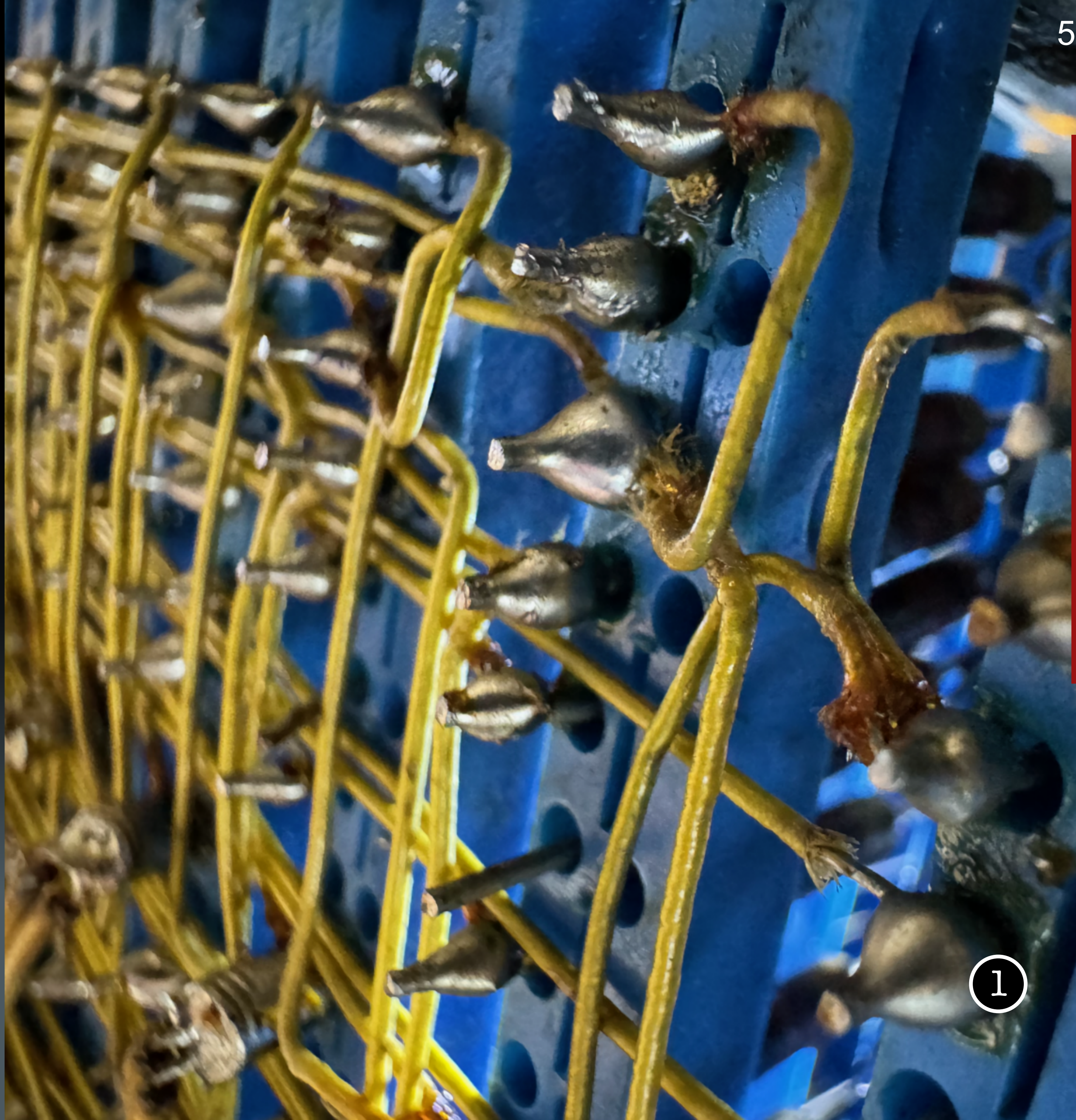
Who Goes Where

Reverse Engineering

At this point, it became mandatory to start understanding how the gears had to turn. A very complex part was to produce the diagram of page 25 with the keyboards wiring, understanding where each wire went. As you can see from the photo ❶ on the right, the contact board wiring is very complex and, at least for me with no musical background, the general scheme was not always intuitive. The reverse engineering included drawing the schematic diagrams we already saw for:

- note oscillators;
- dividers;
- power supply;
- preamplifiers;
- power amplifier;
- tremolo circuit.

❶ Keys are wired from below the contacts board with wire-wrap wire. Each contact has a resistor in series, as can be seen in the photo on the next page.
❷ The circuit seems rather intricate, but it was not too difficult to decode the schematic diagram. The two Eroid red capacitor you see here had to be replaced.



Replaced Parts

Capacitors etc.

We all like to believe that electrolytic capacitors are the most prone to the action of time, but also in this case I checked and found that all of them where still good. I found instead bad all the capacitors of brand Eroid, luckily not very many, and just one of the precision capacitors used in the dividers. Most resistors were still good and only a few required replacement.

❶ A detail of the contact board. Each switch has a 1k resistor in series. Note rows 8 and 9 which mix more signals (lower manual). ❷ Some of the replaced parts. Among them, a 90C1 gas tube, (pointed by the arrow) which died after some hours. I replaced it with a OB2 I had, which produces a slightly higher voltage (108V instead of 90).

First Power On

Let's Go with the Power!

The most dreaded moment of the power up arrived. I was prepared to the most terrible things, but no smoke raised.

Loudspeakers produced the typical sound I remembered, with a light mix of whistles in background, but no sound was produced when I pressed a key, although the typical sound of a working amplifier could be listened.

Why No Sound?

After some work, I could find that one of the lever switches on the amplifier module was not closing its contacts as it should. A river of WD40C, and eventually the sound came.

Most of the keys were still not working, or working terribly, but… it was however a result!

But the worst was going to come…

❶ The switches we talk about in the text. They are used, together with the three black connectors, to divert some signals to external units, like a more powerful amplification system or an echo generator.
The resistive trimmers you can see are for (from the left) oscillators grid potential, Tremolo frequency, Tremolo intensity, general volume, pedal, upper manual and lower manual volume.

❷ One of the infernal inductors that required a lot of pain to be fixed, as we are going to describe. Note the extreme thinness of the wires.

Oh No, Not That!

No, Not That!

The darkest hour arrived. I discovered that many inductors/transformers were broken, i.e., some windings had no more electrical continuity.

Also for the position you must assume to work there, dismounting one of them is simply a nightmare… but almost a dozen seemed an impossible mission, so I decided to give up and to design a new board with modern components, to replace the whole Note Generators Array.

Can We Try?

Two days later, I asked myself if it was possible at least to try the impossible mission. So, with no light at the end of the tunnel, I started removing the first transformer, and understood were the problem was. The incredibly thin winding wires were broken. Maybe some for the action of the time, maybe broken by the compressed air during the clean up (normally they should be protected with a global coating). Whatever the cause, I had to fix them.

Working on those hair-sized wires, as you probably know, is really difficult. They have a coating and the only way I found to remove the coating is scrapping. Even the heat of a match is enough to melt them (the photos can tell you more than any description). Some inductors had broken not the wire, but even the terminal itself.

In some way, I could fix the first of them, then another, then another, until I fixed them all. Still now, I cannot say how I could do that. What you don't do for love…

❶ One of the broken inductors/transformers. Note the screw and the spring that allow to adjust the resonance frequency of the circuit. A practical and efficient way.
❷ The problem: a secondary wire is broken!
❸ The repaired terminal, with the junction ready to be soldered. A good soldering past is strongly recommended.

“Normal” Repairs

At this point, the problem was a “normal” repair of a vacuum tube equipment: some capacitors to replace, some resistors changed their value and required replacement as well. From this point of view, most of the resistors were still in the tolerance range, only those with a minimum dissipation changed more markedly, like the oscillator plate resistors which changed even more than 100%.

❶ The initial condition of the Amplifier/Power Supply module.
❷ One of the expression pedals potentiometers. They come from a time were disassembly and repair was still possible…
❸ One of the capacitive trimmers that set the note frequency in the master oscillator. They also required a lot of time to be fixed, as described in the text.

Capacitive Trimmers

The capacitive trimmers that set the note frequency in the master oscillator where another major issue to be fixed. They are logically very simple: the above disc has a gray part, coated with a metal paint. It can be rotated to vary the coupling with a subsiding metal area. But… if the disc is locked, and if you try to rotate it by the screw, the screw releases from the disc. In the worst cases, the screw also loses its electrical connection with the metal part. Again, a lot of work to fix them all. One could not be fixed and was replaced by a small PCB stamp with a modern trimmer.

Tubes Mess

Tubes Efficiency

This topic means pain to me, because more than two third of the more than 50 ECC82 tubes are exhausted, as I could verify using the extraordinary TV-7 tube tester from my friend **Francesco Sartorello**, a real tube expert, never thanked enough.

In theory, these tubes should not work any longer, because on the TV-7 they can produce a value of only 20, when the minimum accepted would be 56.

But carefully switching their place, I could find a combination where the tubes are exhausted but the organ works. Definitely, I am not going to investigate why…

Sly and Dupe

Why don't you buy new tubes, you could ask me? My father used to tell me *"The sly-man leaves home in the morning, meets a dupe-man and the deal is done"*. I mean that the tube market is today drugged by hi-fi enthusiasts, and an ECC82 (12AU7) tube costs from 15 to more than 300 euros on eBay (see the fragment below).

The TV-7 Tube Tester

A TV-7 tube tester is a piece of electronic test equipment designed to test vacuum tubes, which were widely used in radios, televisions, and other electronic devices before the advent of transistors and integrated circuits. Manufactured primarily during the 1950s and 1960s, the TV-7 series was used by the U.S. military and is still popular among vintage electronics enthusiasts today. Find its description in my e-book "Surplus Photo-Parade", you can download from my web page www.k100.biz.

❶ Treatment of the top cover; note the difference with the non-treated part.
❷ treatment of the pedalboard. Here as well you can see the difference of the treated part.
❸ S22 rear view.

Wood Treatment

A Good Product

The S22 housing is not a precious piece of art furniture but is however a nice wooden cabinet. It did what it could to protect the interiors, but suffered very much for the bad location where it was placed.

Some parts still require repairs, but in the meanwhile I found a very good German product (Borma Wachs) which helped it to acquire again the good look you can see in these photos.

To be noted the very heavy weight of all the wooden parts. It means that it is a very good and “dense” wood; this is probably the reason why it could survive its epic story.

Conclusions

As I said initially, this was an out-of-standard and extra-long adventure, where I could put to good use the experience I acquired with all the other restorations of electronic instruments.

As you can understand, it was also a great joy for me to save this old friend, which unfortunately I am no longer able to play, even in a minimal way. But I am probably finding a friend capable of…

Obviously, during the restoration, I used mainly vintage equipment, like the Tektronix 324 portable oscilloscope, invaluable for being small, light and, above all, battery operated, a quality that you appreciate at most when as I said, you need to work on all fours… Other fellows in this enterprise were the Philips PM3350 oscilloscope, the Tektronix 7633 CRT storage oscilloscope, and the Hewlett Packard 5316B Universal Counter, all described in my e-books.

During this job, I produced more information that that reported here. Should someone be interested, I will be glad helping them, but it seems not very probable that someone else wants to restore an organ like this…