Audio Restoration Project: Repair B&O Bang and Olufsen BeoGram 4000 / 4002 / 4004 / 6000 Tangential Turntable

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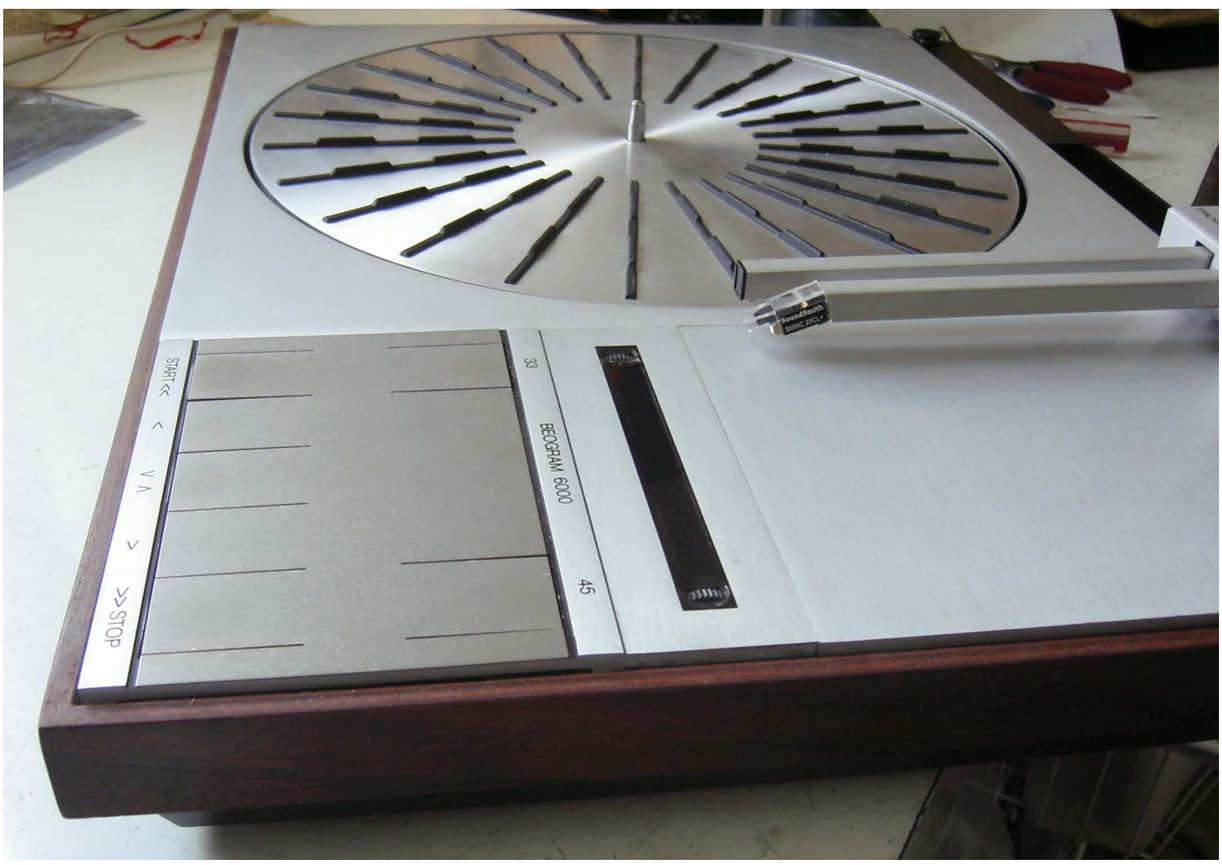
Bang and Olufsen introduced the world's first tangential-tracking turntable (Zero tracking error) - the BeoGram 4000, in 1972. It has a permanent place in the NY Museum of Modern Art. The updated models (produced from 1974 to 1980) were available as the BG4002 - a stereo version (without a built-in RIAA amplifier), and as the BG6000 quadraphonic version with a built in CD4 demodulator / RIAA amplifier.

This superbly designed and over-engineered BG4002 / 6000 version remains the most widely still available today, and with proper maintenance will last 100 years, if not more.

This article describes how to perform a complete restoration of this model, including taking care of all known failures and defects. The Manufacturer's Service Manual, available from BeoWorld, is an integral component of the proper restoration process.

There are slight differences in the circuits between the various types, but these are covered in the individual Service Manuals, available on the Beoworld.org website.

This article covers, by and large, the following BeoGram type numbers:
Beogram 4000 - 5215
BeoGram 4002 - 5501 , 5503 , 5504 , 5511 , 5513 , 5514 , 5521 , 5523 , 5524
BeoGram 4004 - 5525 , 5526 , 5527
BeoGram 6000 – 5502 , 5505 , 5511 , 5515

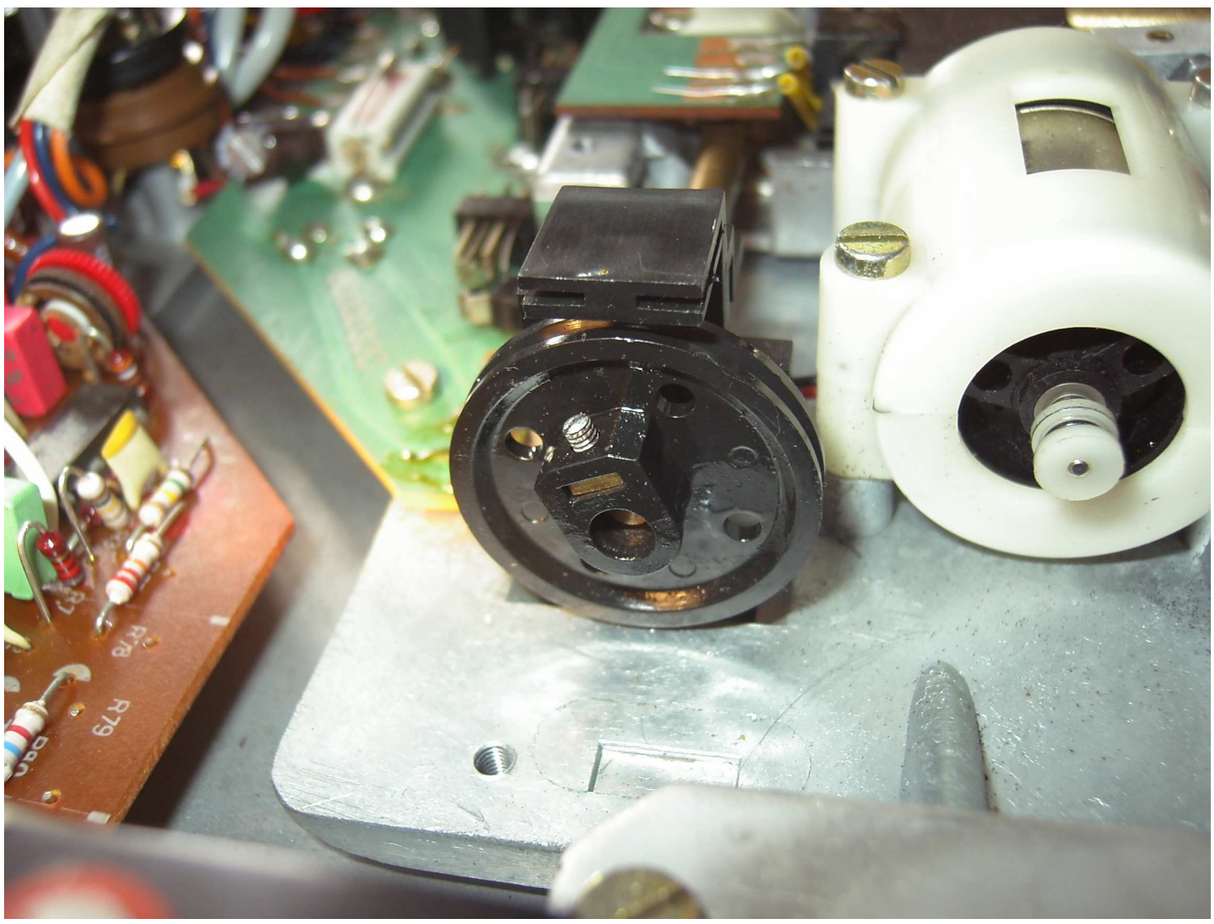


1. Replace the Rubber Drive Belts

When selecting a 45 record, the arm would lower at the 33 LP landing zone, the first-time. The worn out belt was slipping, and the platter didn't reach correct speed in time for the detector circuit to "see" it!

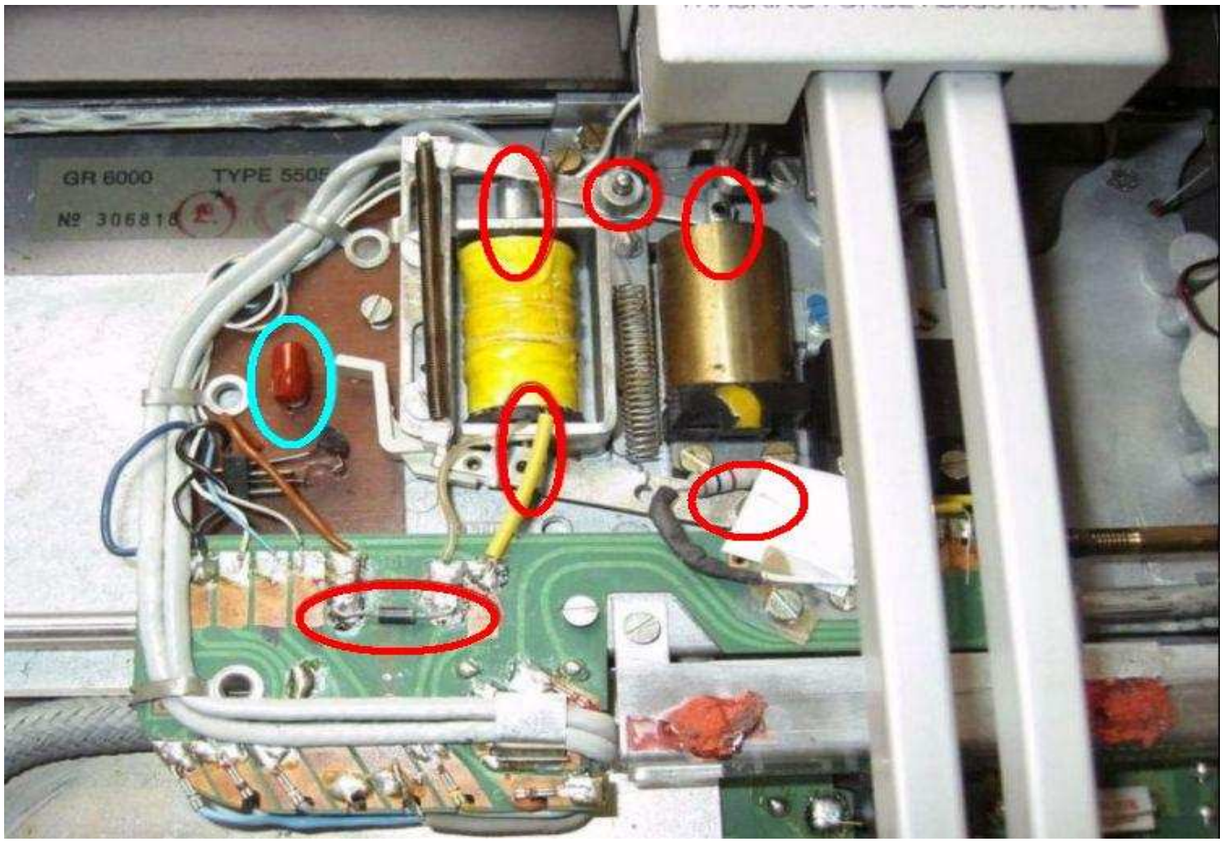
Of course, on the second try, it was already turning, so it would lower correctly at the 45 zone... there's a filter in the detection circuit, and it needs the correct frequency of moving bars under the sensor.

There is also a second smaller belt which moves the tone-arm left and right. This is on the DC motor.



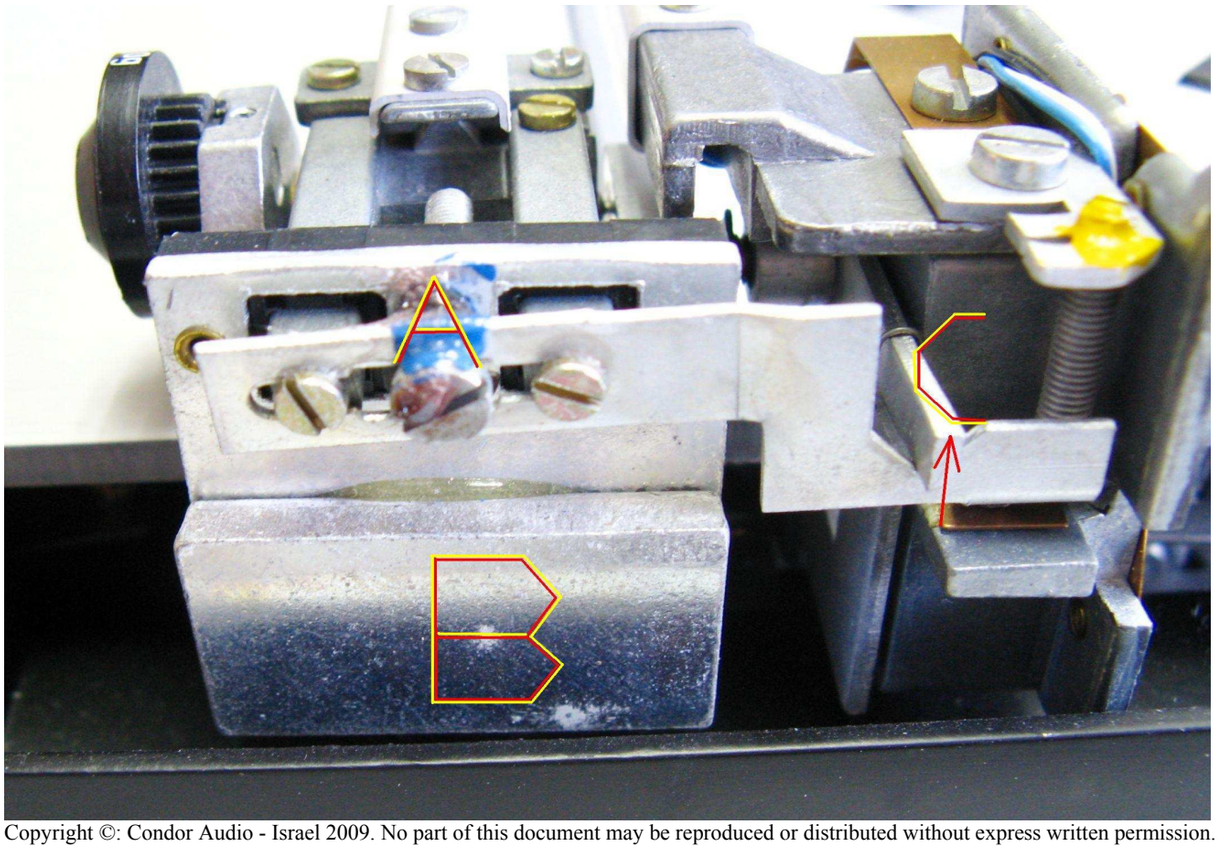
2. Lubrication

Lubrication of ALL these points is incredibly important.
If the arm does not lower (barring any severe electrical problem), the cause is dried / coagulated lubricant on the RED circled areas. If you can see any dried grease, remove it.
Then gently squirt Sewing Machine oil onto:
1. Both ends of the Yellow Solenoid Piston (Thick and Thin parts)
2. The Piston of the Copper Damper
3. The Axle pivot connecting the Solenoid and Damper



3. Zero-Balancing the Tone-arm

Over time, the bolt (A) holding the tone-arm's counterweight (B) works itself loose, and the tone-arm is no longer in perfect balance. Sound is adversely affected. Leave the cartridge attached to the tone-arm during this procedure.

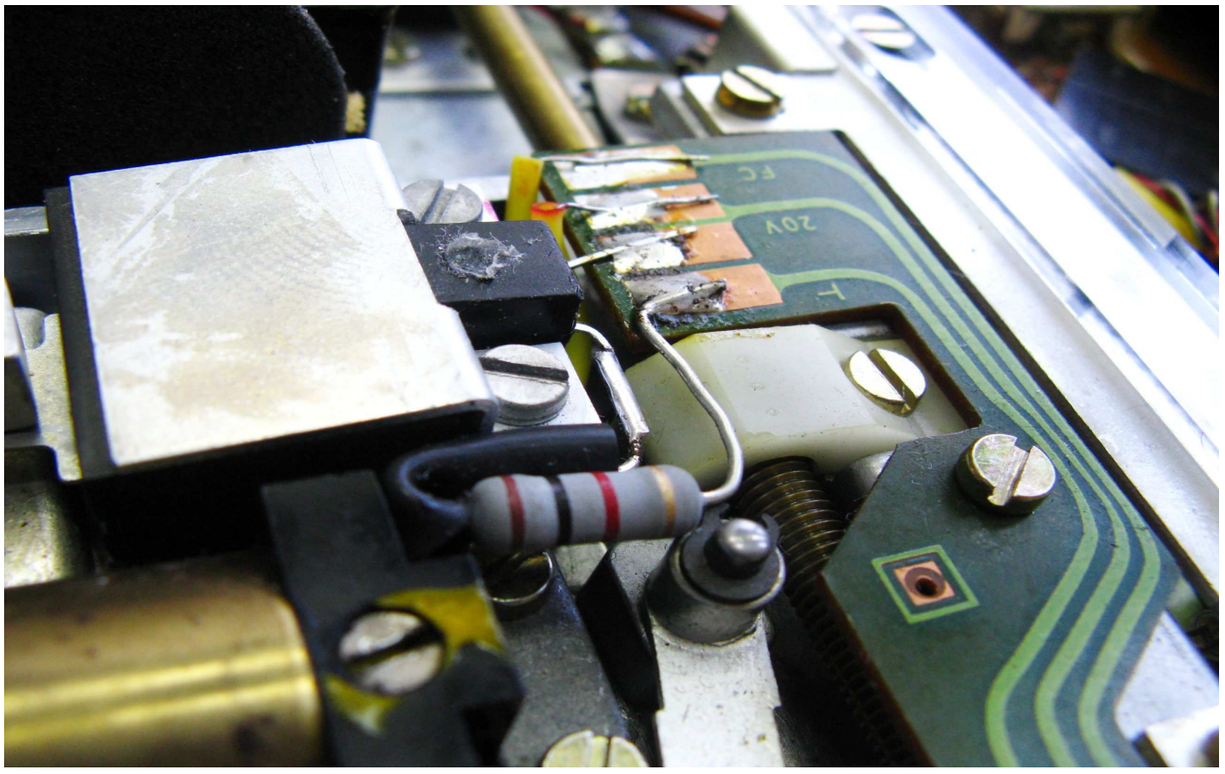


1. Set the round Tracking-weight wheel to 0 grams.
2. Lift up the spring-loaded arm (C) , and keep holding it up.
3. Tighten or Loosen bolt A (sometimes it may have old lacquer securing it), all the while tapping the tone-arm gently, until you feel that it is in perfect longitudinal balance.
4. Release Arm C, apply new lacquer on bolt A, and rotate the tracking-weight to that appropriate for your cartridge.
5. Other mechanical adjustments need to be made – reference to the Service Manual is recommended.

4. PCB 8005013 Modification

Replace the 1N4004 Diode, with a high-speed UF4007 (See picture 2 above) - this also helped to solve the problem with the arm not lowering at the correct point, when starting to play an LP.

I converted the Photo-resistor bulb OIL2 to a White high-intensity 3.0V LED and a 1K resistor (see picture below). This is by no means necessary, but it's one less thing (burnt-out bulb) to have to worry about in the long run.



5. PCB 8009028 Modification

I also replaced the 22nF Capacitor with a Panasonic Polypropylene unit (See picture 2 above).

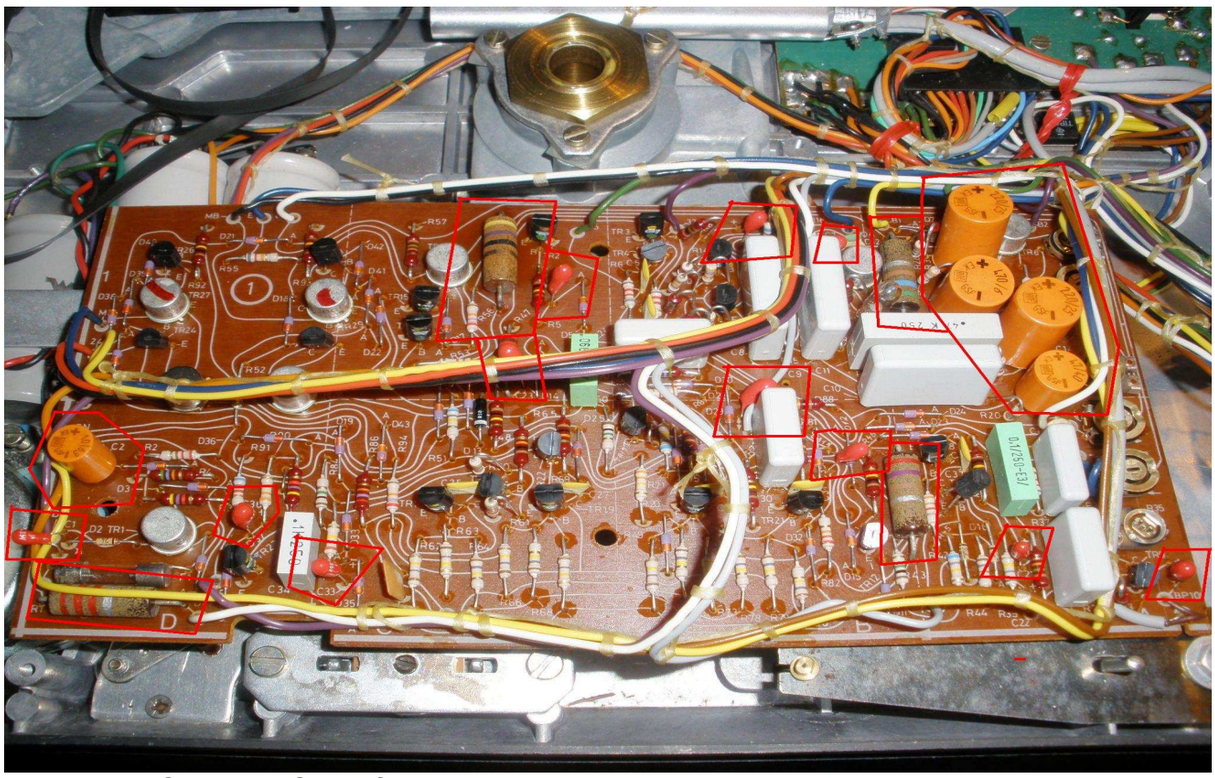
6. 33/45 Speed Problem; PCB 8009024 or 8009033

When pressing START <<, The 33 indicator light (on the left of the red 4ch light), illuminates for a split second, and then immediately, the 45 indicator light illuminates, and remains illuminated (with platter speed 45, as indicated by the light).

This is while the tone arm is still moving to the left slowly over the flat aluminum plate, BEFORE the tone arm even reaches the edge of the platter, let alone the LP.

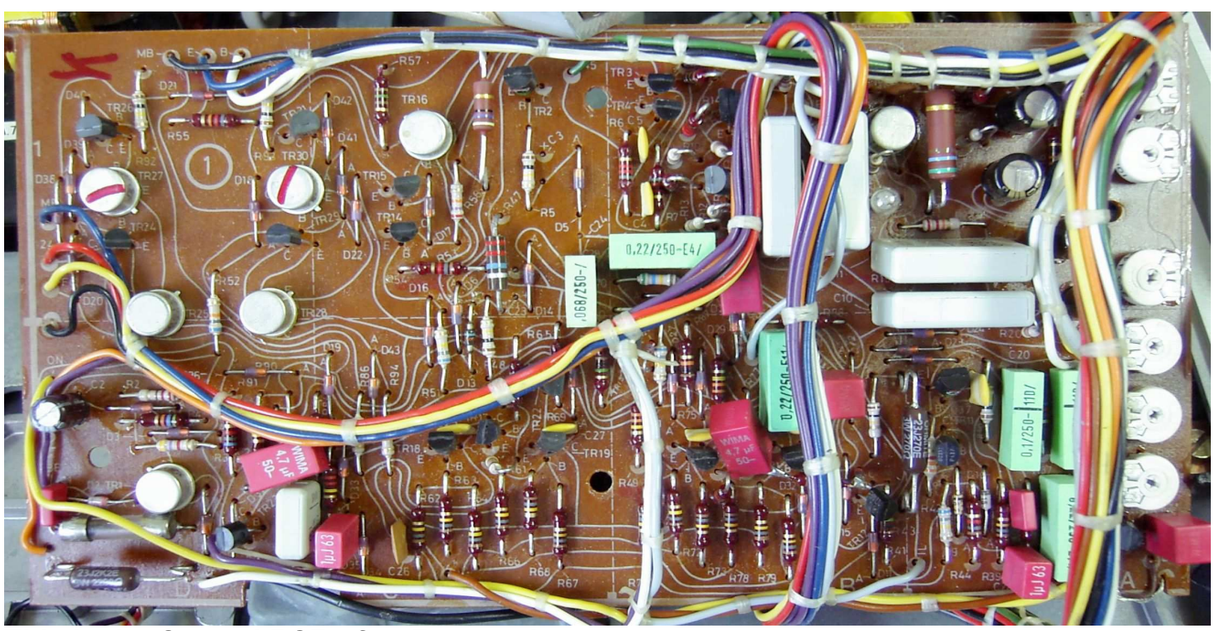
In short, there was a problem in the 33 circuit, which the previous owner had skillfully hidden by disconnecting the 33 indicator bulb.

When I connected the 33 bulb to the circuit, this above problem appeared.



This is the Control PCB before Restoration, showing the components to be replaced

It was repaired by the following:
1. Replacing D6 - 1N4148
2. Replacing C4 and C5 - 3.3nF with Panasonic Polypropylene units
3. Restripping and Resoldering all the coloured wires onto the PCB - many were frayed, and a couple were hanging on by their last strands.
4. Replacing all Electrolytic and Tantalum Capacitors as follows: >10uF with Panasonic FM units, and < 4.7uF with Wima MKS2 and Panasonic Propylene units. Note that some of the Capacitors must be mounted horizontally, to prevent contact with the suspension plate underneath the PCB.
5. The 6 oxidized potentiometers at the right were replaced by Piher PTC10 Cermet units.



This is the Control PCB after Restoration

7. PCB 8009024 or 8009033 Repair, Low supply voltage

The main supply voltage rail to the circuit should be 31V. I was measuring 27.2V. Because all the capacitors and a couple of isolated bad resistors had been replaced already, the place to look was at the semiconductors.

All diodes checked just fine – I have very rarely found a bad diode (all made by Philips in the old days) in vintage B&O equipment, so I was not expecting to find any bad diodes here.
Although all the transistors on the Control PCB appeared to be OK while testing with power off, past experience has shown this not to be the case, when operating under load.

I concentrated on the can transistors on the left side in the above picture. I replaced one pair at a time, with new hFe matched pairs. Modern BC550 (NPN) and BC560 (PNP) are excellent substitutes for the originals.
The following are the results of the change, affecting the 27.2V (31V) supply rail:
TR3 & TR4: +0.3V
TR5 & TR6: +0.2V
TR14 & TR15: +3.1V
TR26 & TR31: +0.15V

With these 8 transistors replaced, the main voltage rail now measured the specified 31V.

8. PCB 8009032 Modification, LP prematurely ends play

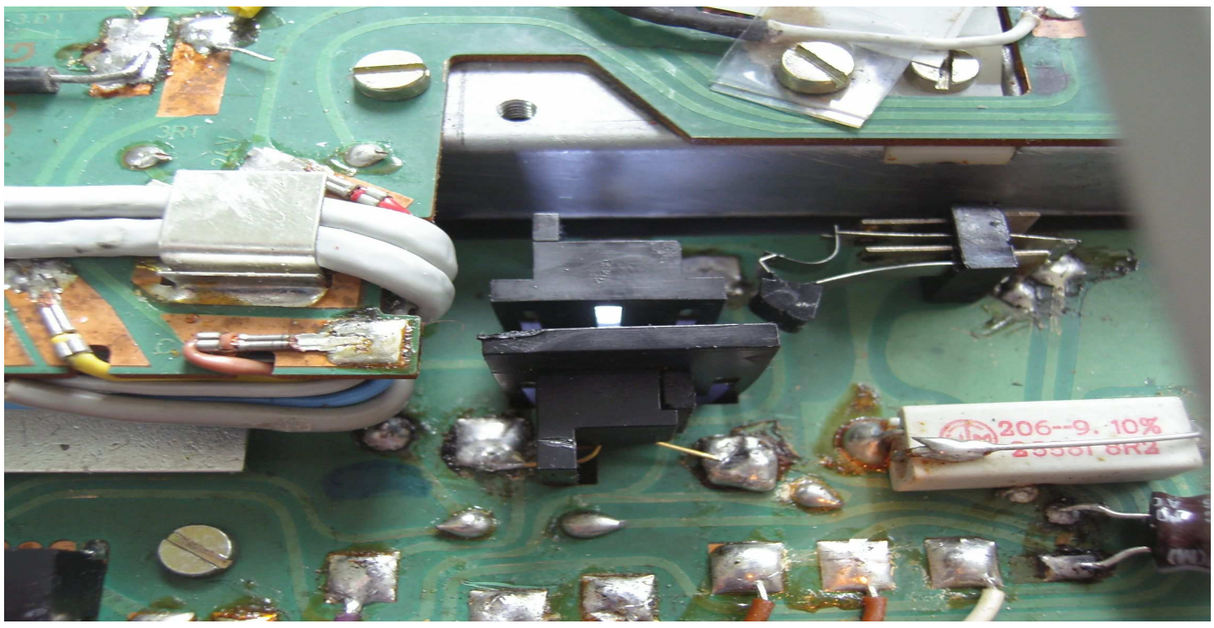
There is an ongoing problem with the Photo-transistor, and having to adjust the incandescent lamp, so that the light reaches the transistor correctly.

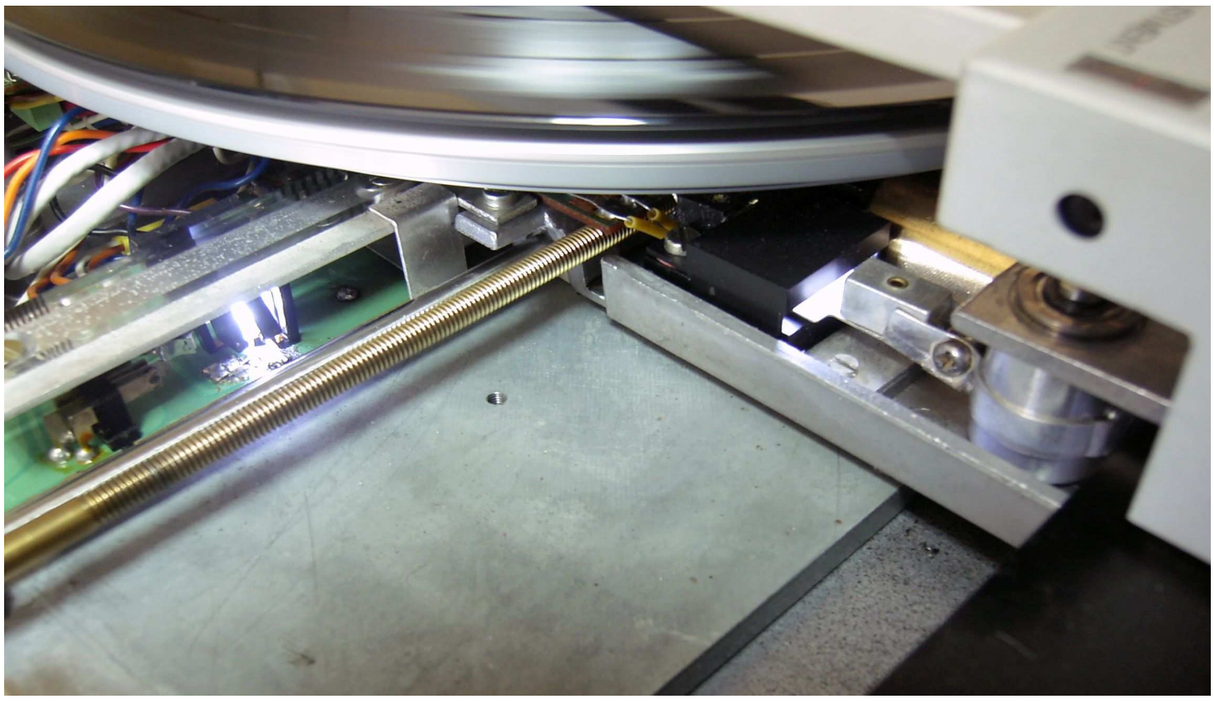
Note: On later production units of Type 551x, this lamp has already been changed to an LED, and so no modification is necessary.

I decided to go for overkill - I replaced the 24V 25mA lamp (IL1) with an opaque white medium-intensity 3V LED. This light from this LED is highly directional, and much more intense than the original lamp. So the Photo-transistor, on my unit a Motorola 2N5779, should be able to sense the light more precisely now.

The 82 Ohm resistor (R4) from the Cathode to Ground must also be replaced by a 1Kohm 1W resistor.

Before replacing the clear acrylic ruler with the black stripes, make sure that it is absolutely clean, with no finger- or other marks!

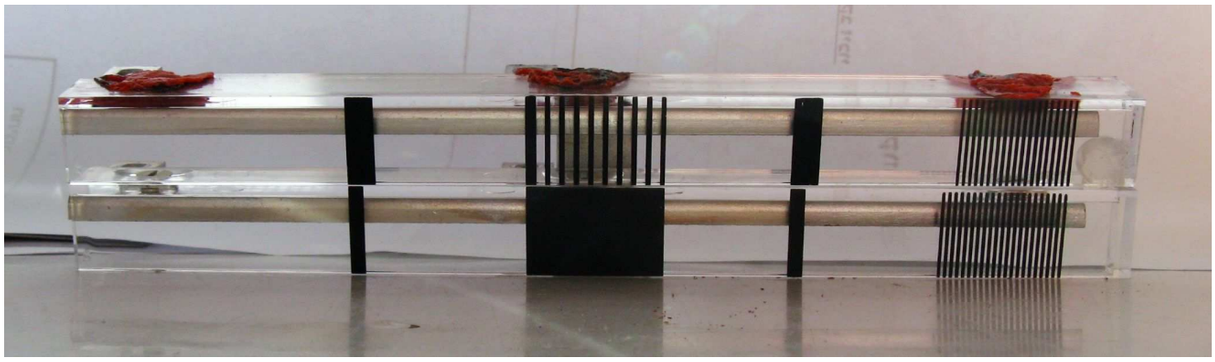




9. Tone-arm does not Lift-and-Return at End-of-Play

The very first production units appear to suffer from this fault, more than later models. I am speculating that the design-engineers based their lateral distance movement calculations on older LP's whose End-of-Play position was much closer to the centre hole. Later LP's cut down on playing time, and the End-of-Play position was much further away from the centre-hole.

Here are 2 Rulers from the Optical-sensing circuit.

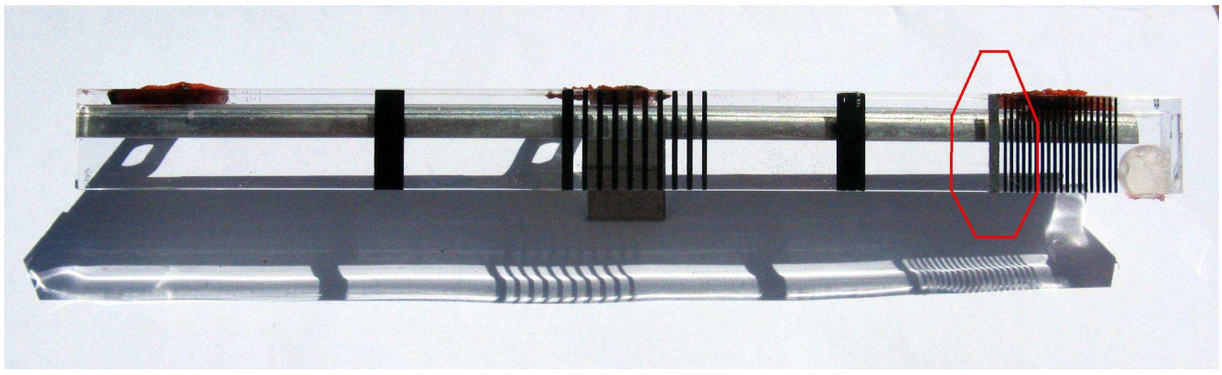


The top one is an early-production unit, and the bottom one is a later-production unit.

The critical difference is at the vertical bars on the right-hand side – this is the End-of-Play signal.

The top one requires the stylus to keep tracking to a later (closer to the centre-hole) position, before signaling "Lift-and-Return".
But if you are playing a later LP, the stylus will never reach that position, so will not "Lift-and-Return"

The solution is to add a single wide stripe at that position, as shown below. The stylus will then "Lift-and-Return" correctly.

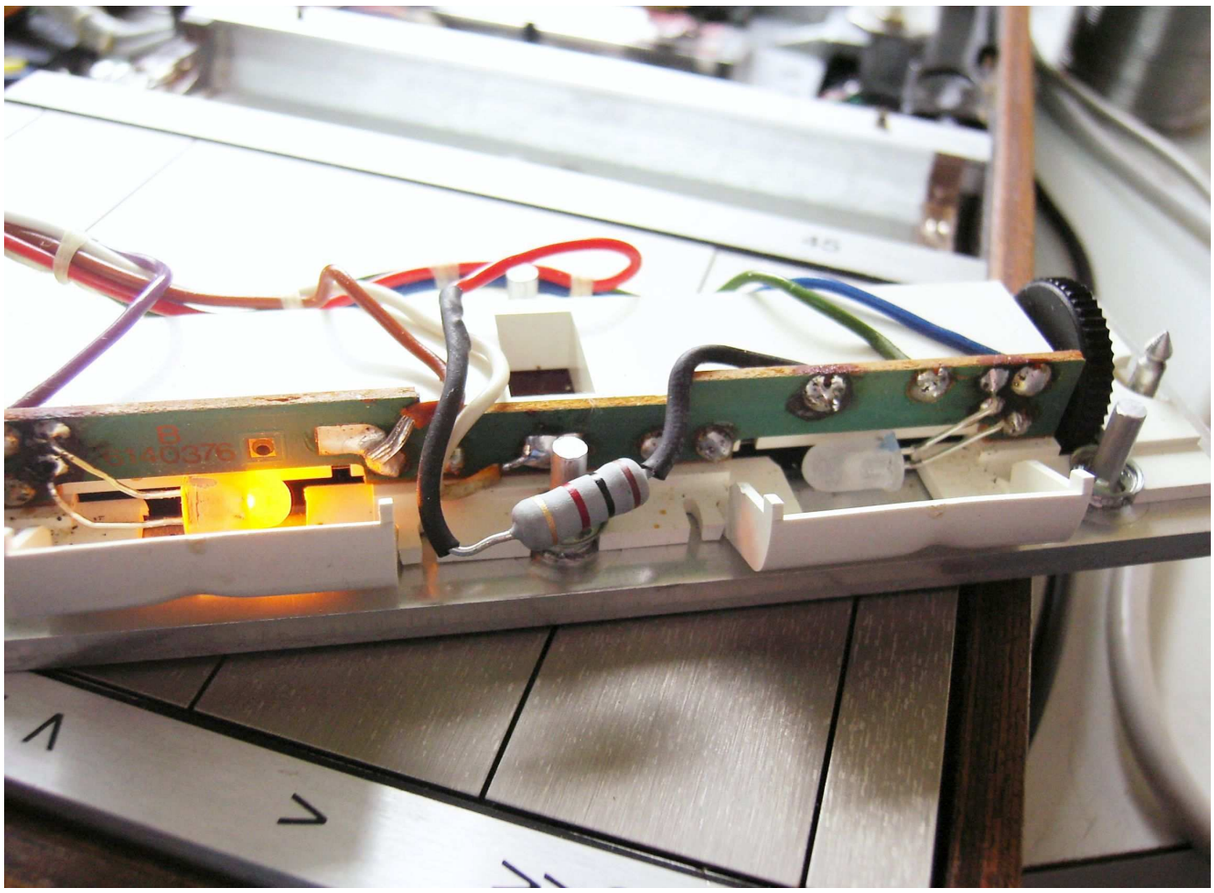


The bolts securing the acrylic ruler to the aluminum mounting bar have been sealed with old-style red sealing wax.

10. 33 / 45 Speed Indicator LED upgrade

The 33 and 45 indicator lamps heat up, and deform their plastic housings.
I am a fan of LED's, primarily because of their long-life, cool operation, and highly-directional intensity, even though the associated resistor warms up while killing excess voltage.
And I also know that some purists object to the use of LED's - and that's OK. I respect their opinions, and I have learnt a lot from them!
Anyway, this LED upgrade works beautifully, and does so without adversely affecting the required voltages on the Flip-Flop circuit (called a "Vienna-Bridge" in the Service Manual). I had feared that the voltage difference (17VDC instead of 22VDC at the switches) would affect the function, but further testing shows that all is OK.

In the picture, on the white plastic hinged shields, you can see the yellowish damage, due to heat emitted by the standard incandescent lamps.
Parts required (total cost less than $1)
2 x Yellow LED's 1.8V, Intensity >10,000mcd
1 x 1000 Ohm, 1 Watt metal film resistor
Some heat-shrink tubing.



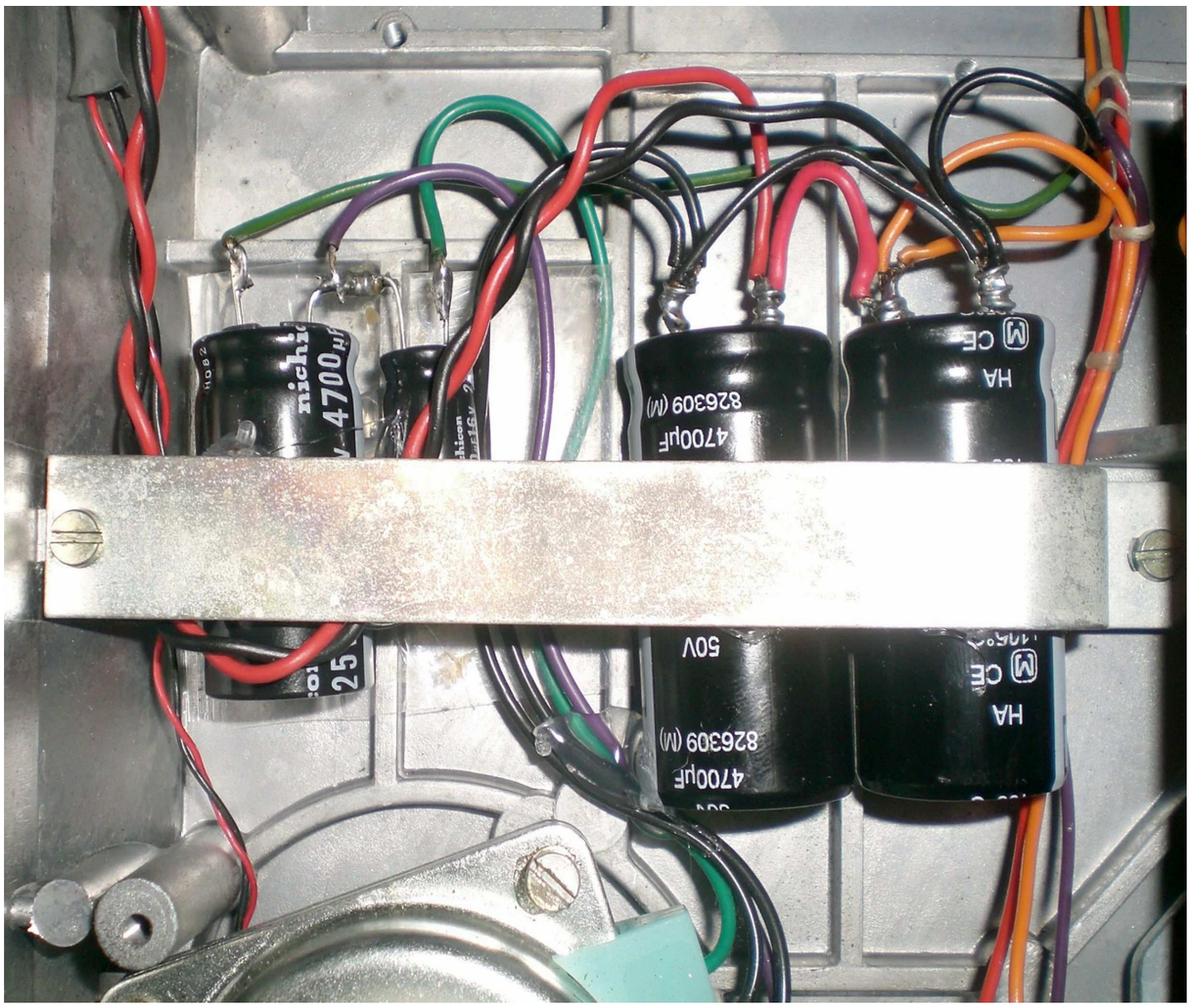
Current to illuminate the 33/45 Speed lights is supplied by the Red wire.
The voltage present on the Red wire is 22.8VDC positive, which has to be reduced to about 2 Volts.
I chose a 1 Watt resistor (1/2 Watt would normally be enough), because the resistor carries the excess voltage, and heats up. Using a 1 Watt resistor, results in a much cooler resistor.

I unsoldered the Red wire from the PCB, and soldered one end of the resistor in its place.
I soldered the other end of the resistor to the Red wire.
I placed the resistor at a small distance from the white plastic housing (around the metal bolt), to eliminate the possiblity of heat damage.
The LED's must be sanded lightly to give an opaque appearance, to distribute the light evenly.

I marked the -ve lead of the LED with a blue marker, which you can see faintly on the upper edge of the LED. If the LED's polarity is incorrect, it will not illuminate.
In the picture, the LED's upper conductor is -ve, and the lower is +ve.

11. Replacement of 4 Main Power Capacitors on Chassis

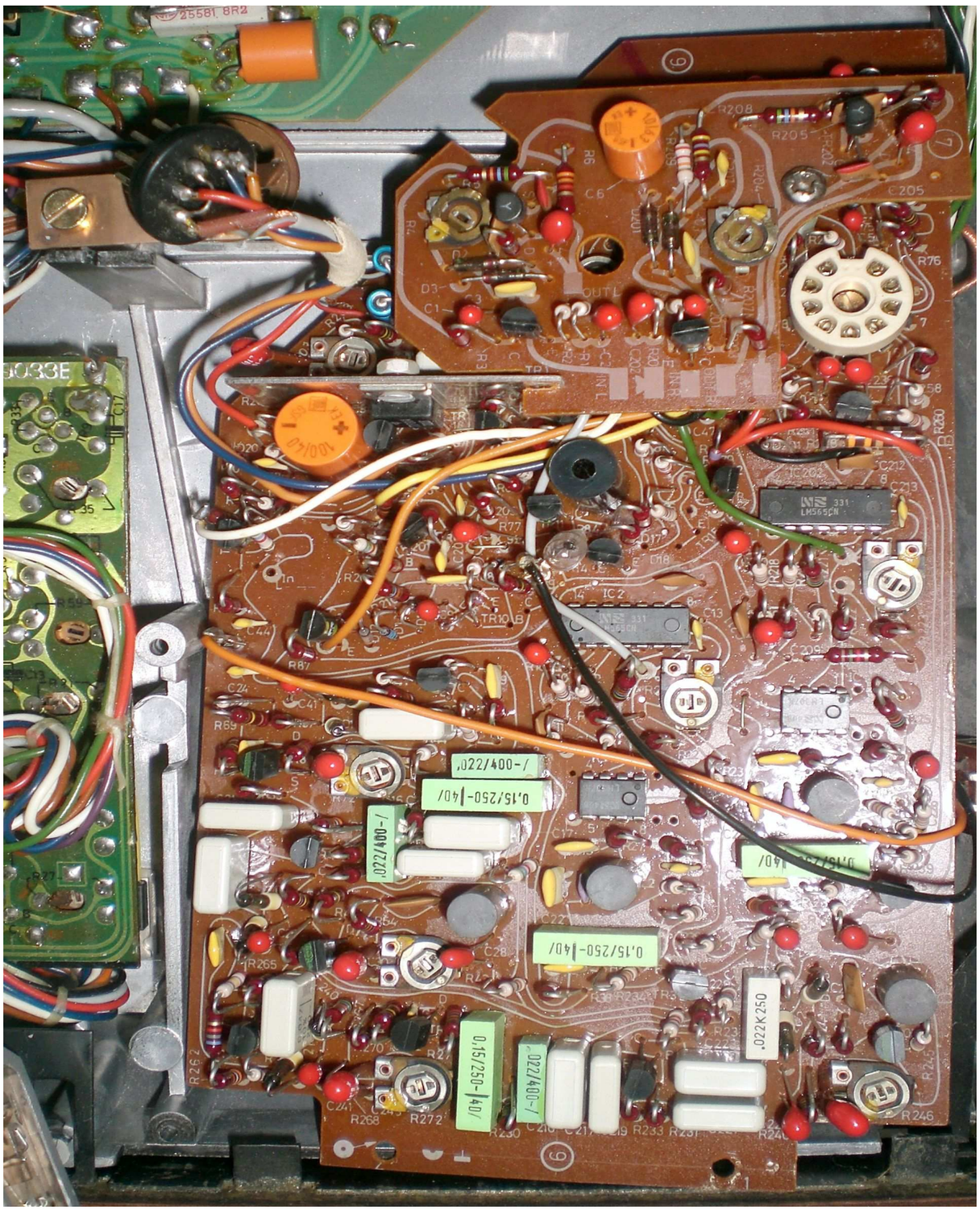
I replaced the 2 main 4700uF Decoupling caps with Panasonic TSHA units, the motor phase cap with a Nichicon 220uF Bipolar unit, and the 3rd 4700uF Decoupling cap with a Nichicon HE unit.



12. Beogram 6000 Muddy Sound with CD-4 RIAA PCB 8005012

IMHO, this CD4 demodulator is actually one of the finest RIAA amplifiers ever made. So I wanted the best audio capacitors possible to extract every last nuance of sound from this board.

This is the RIAA PCB before Modification:

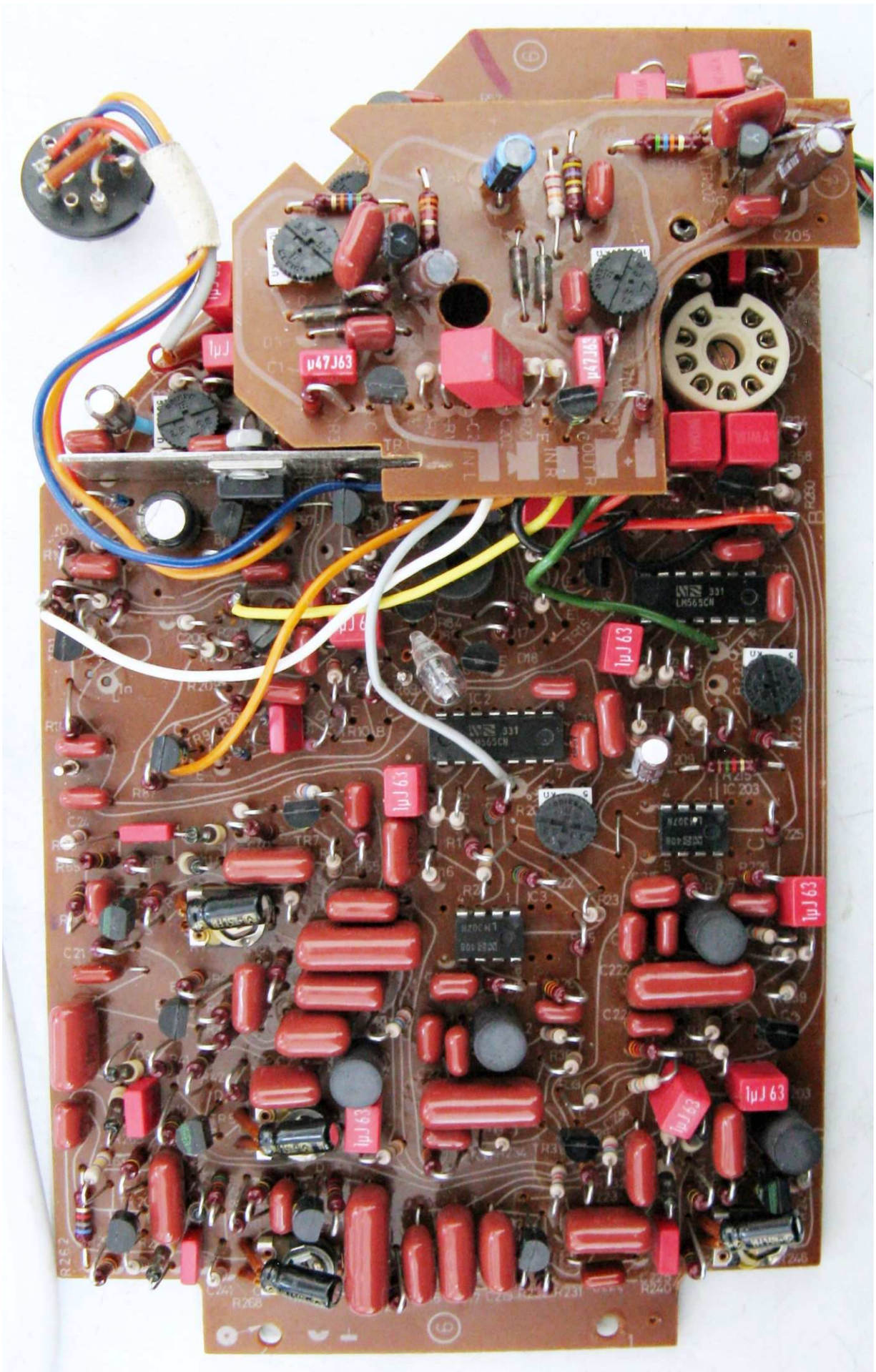


I replaced all the Electrolytic and Tantalum Caps with a nice blend of Panasonic FM and ECQP, Elna Silmic II, and Wima MKS2 caps, and the potentiometers with Bourns 3352 Cermet units.

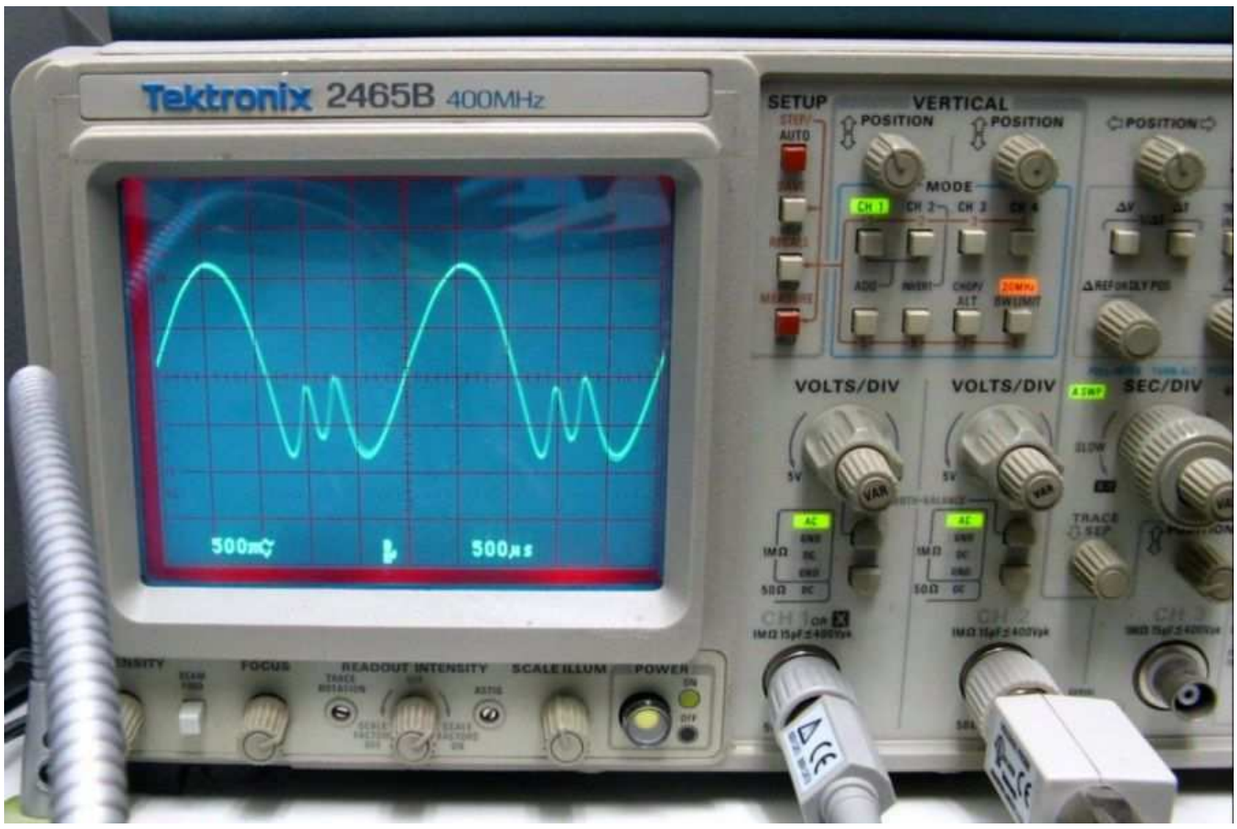
I advise against fiddling with the potentiometers on this PCB – they are for balance and separation only, and cannot improve distorted sound – that is definitely a capacitor problem.

If the sound is seriously distorted, this PCB must be calibrated with the necessary CD4 calibration equipment. I am pleased to be able to offer this service to my customers.

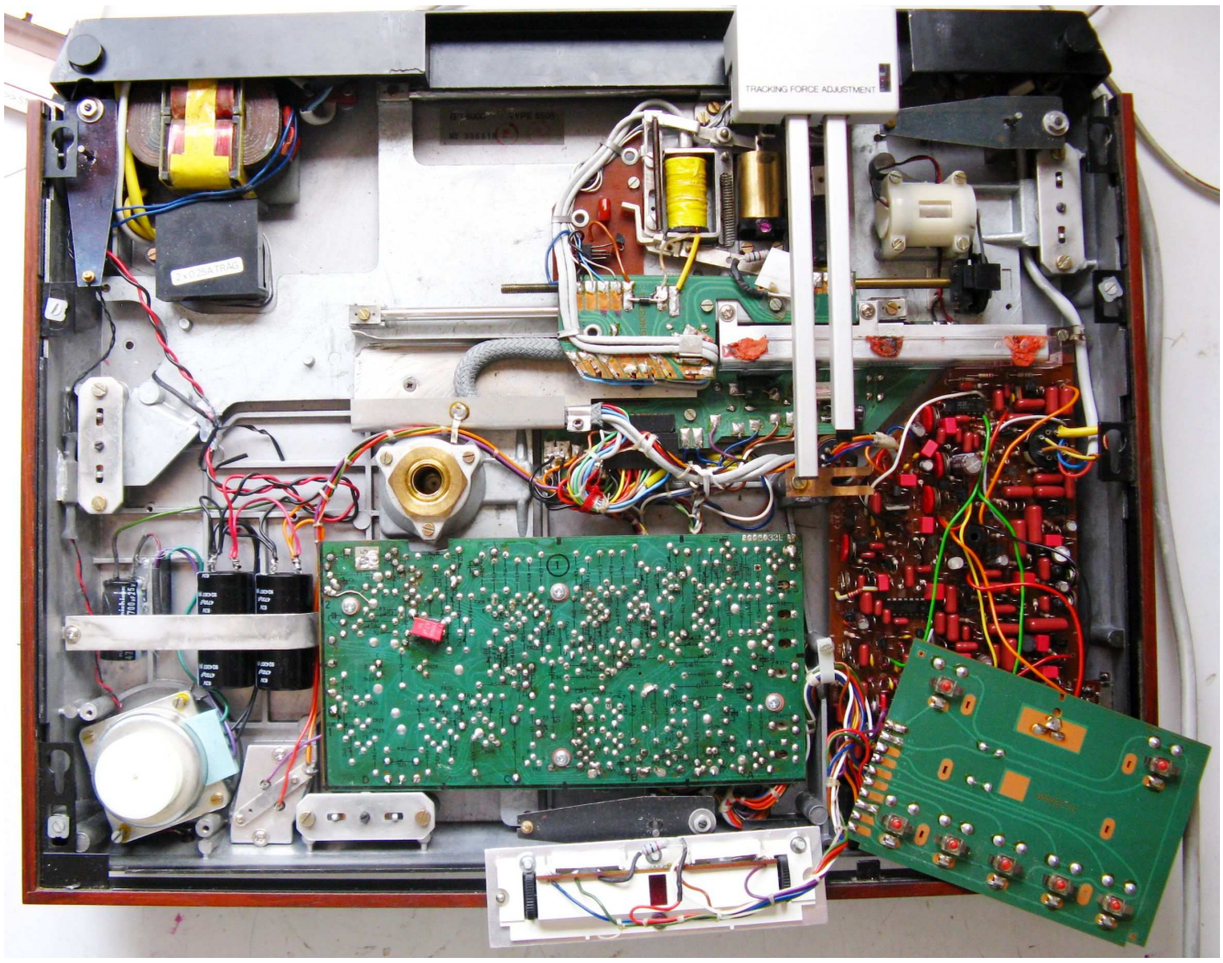
This is the RIAA PCB after Modification:



13. This shows the CD4 alignment signal on the RIAA amplifier adjusted according to the Service Manual.



14. This is the totally restored interior



15. Parts for this restoration

Parts and advice are available for owners who wish to tackle this project by themselves.
http://www.condoraudio.com

yachadm@gmail.com