Restoring a Pioneer RT-909 Reel-to-Reel

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Part I
Introduction

The RT-909 is by far the nicest consumer reel-to-reel Pioneer ever produced. It is rack-mountable, handles 10.5" reels, is a dual-capstan, closed-loop servo controlled drive, electro-motive reel braking, with auto-reverse capability. The design is truly simple, yet elegant, doing away with most of the complicated mechanism of many of the other decks in its league. The unit I just restored has playback response of 20-20Khz +/- 0.5db, at -10db modulation, which blew me away when I heard it put it all together. My main rig will never be without a one of these beauties. It is no wonder that so many of these units were sold back in the day, even as expensive as they were ($1100 1979 dollars).

This thread is for those who have had an RT-909 since they bought it new, or discovered Dad's RT-909 in the closet, and want it to perform up to, or exceeding, original factory specs. After almost 30 years all of these will need some restoration operations performed on them, even if they appear to 'work'. They may work, but you will never know what they can 'do' until you bring them back up to full steam.

Here is an overall list of operations I perform on these units, before offering them for sale (in my opinion, none are optional):

1. Perform a complete initial functional test, to determine if there are any repair operations need to be performed before restoration, and to provide a baseline for comparison with post-restoration performance.

2. Replace both pinch rollers (for some reason, all RT-909 original pinch rollers are gooey/gummy at this age), and adjust the pinch roller pressure. Rollers are still available from Pioneer at a reasonable cost.

3. Replace the capstan drive belt, also still available from Pioneer.

4. Replace the felt brake pads (felt brake pads that are almost 30 years old probably have dried out adhesive, and may appear to work, but we are shooting for another 20-30 years of use here).

5. Rebuild the tension rollers (they all need to be cleaned, lubed, and fresh damping fluid added), and replace the tape sensor micro-switches (they all are somewhat corroded at this age)

6. Completely disassemble, clean, lube and adjust the transport mechanism (a real contributng operation to sonic performance, like wow and flutter).

7. Adjust reel torques (braking, take-up, back, FF and REW).

8. Clean and deoxidize all user controls and internal switches/contacts (most units have dirty controls).

9. Relap the heads (an absolute necessity if you are going to change how the heads are aligned at all, since they normally have significant wear grooves in them).

10. Rotate all tape guides (necessary, since they also develop wear grooves from the tape passing over them)

11. Replace all electrolytic capacitors (they have only a 20-30 year lifespan)

12. Refresh all circuit board solder joints (flow-soldered joints also have only about a 30 year lifespan): a small amount of fresh solder (with fresh flux) is added, then the joint is quickly swirled to mix it up, while watching for good solder wetting on the lead. If adding a small amount of additional solder would result in a blob, the joint is sucked clean and a new fresh joint is applied. All of this is done with as short a period of heat application as possible, to minimize thermal shock on the old parts. Also, stay off of joints that are thermally connected to styrol caps (polystyrene), unless absolutely necessary. I mark the joints to stay off of with a red sharpie, which washes off when the flux is cleaned off.

13. Verify the power supply voltages and filtering.

14. Perform a complete REC/PLAY alignment/calibration (head alignments, bias, equalization, levels, meter indications, etc.), optimizing performance for the owner/customer's blank tape selection (necessary for best performance).

15. Extended functional testing (over several days), to determine the effects of the restoration, and to ensure that nothing was missed, or damaged.

16. Perform a complete cosmetic detailing (there are a couple of tricks and gotchas, even for this operation).

The Pioneer RT-909 has 8 circuit boards, with 121 caps, and the parts cost for the caps alone is approximately $65.00. The labor for the complete restoration, for a good tech, will likely be 30 to 40 hours.

Here is what you can expect from the unit. I have not encountered one that did not have at least most of these issues:

- Dirty/corroded user controls, especially the pitch control, resulting in noise when levels are adjusted, and speed fluctuations while running.
- Gummy pinch rollers. Initially seem to be OK, until you try to clean them, then they get sticky.
- Dirty/corroded tape sensor switches (one in each tension roller assy), resulting in intermittent operation.
- Poor reel torque settings, particularly back-torque in both directions, generally resulting in intermittent termination of play, as tension arms are allowed to collapse to unloaded position.

1 Vintage Restoration Boiler Plate

First a bit of boiler-plate DIY info:

- If you are an impatient individual, tending to get frustrated, and force things, or get rough. DO NOT attempt this operation. You could very easily wind up with a pretty, brushed aluminum paperweight. Generally, if a unit is fresh, and unmolested, it is less expensive for a knowledgeable tech to restore/repair. If I have to clean up a ham-handed, fumbled job, it will definitely cost ya.
- Make sure that your tools are in good condition. For example, if the tips of your screwdrivers are worn, you will damage the heads of your screws (some are in pretty tight), and you will play heck trying to get them out. New screwdrivers make all the difference in the world. All it takes is for your driver to slip one good time in a stubborn phillips head screw, and you could make it next to impossible to remove, and you will damage your driver as well (take a look at your old phillips screwdriver).
- Do not get curious about additional details of the mechanism. There are an abundance of tiny little parts just waiting to jump out of your machine and into the nether world if you are not careful or know what to expect. These little parts can be worth the entire cost of your machine, since, if you do not find them, or if you break them, you will have a non-functional unit.
- Unless you have an idetic memory (photographic), take pics, notes, etc., as you go. It is not a good thing to have extra parts left over at the end of a job. I have a large supply of tiny zip-lock bags which I use to put parts from various stages of work. In this way the number of screws, or a couple of screws and a spring or c-clip will key my memory to the stage or assembly they go back into.
- There are no magic bullet chemicals. Use each chemical or lubricant, etc., only where it is appropriate. If not, you have a paperweight again. If you are not sure what to use where, seek wise counsel, from reputable sources.

- Before you do any disassembly or work, put a baggie over your power plug, and hold it on with a rubber band. The very last thing you want to do, is get surprised by a spark, or G_d-forbid, a jolt. Guess what...paperweight time again.

- NEVER force ANYTHING. If you have to force it, you are not doing it right and you will likely break something, or get a part on wrong...paperweight time again (Getting irritated at that phrase? Good.).

- Mickey Mouse has no place in a vintage restoration shop. NO half-tail operations, no funky monkey rigging, no time bombs for someone else to clean up. I cannot tell you how many times I have seen serious "just enough to get by" kind of repairs (blobs of glue to replace lost c-clips, weird wire twists holding on broken parts, etc.) If you break or lose something, buy a parts unit and replace it right. Chewing gum, bailing-wire rigs will ALWAYS come back to bite you.

- There are innumerable tricks of the trade that are too detailed to discuss in a DIY thread (how to hold a tool, how to keep a c-clip from jumping across a room, etc.). Be prepared to learn some/many of them the hard way (by experience). Sorry folks, it comes with the territory.

- Get a service manual. They are just too readily available to justify flying blind. If you are a cheap _ _ _ _ _ _ _ _, buy one on CD. They are only around $10 on the bay. I prefer originals. The color coding in the drawings is a real help to an old man like me.

- Go slow. Be meticulous. Double and triple check everything. It is easier to take the extra time to do it right the first time, than to have to take the time to troubleshoot and repair any mistakes.

- When wires are attached to boards being worked on, try to tie them to the board, so that the wires will flex at the tie-point, rather than at their attachment points. This will keep you from making stressed connections that will break in shipment or later. Also, note wire bundle ties and remove them, to gain as free access as possible. You may be moving the boards around quite a bit, accessing top and bottom, over and over again. Please take special note, even photos, of which wires are in which bundles, and where they are tied in bundles. If you just bundle up wires to look nice, you could get wrong wires in close association with each other, and introduce hum or other kinds of noise or feedback loops.

- Note that many times the screws holding motor plates, etc, are dabbed with some sort of locking varnish, typically greenish or bluish. It is hard for me to believe it, but that stuff really works well, and if you will chip it away before trying to remove the screws, you will have a better time getting the screws to let go. One woudl think that the stuff would just break free as you torque on the screws, and away you go, but NO!

Last but not least...I accept no responsibility for how well or successful you may be at performing this operation. Results will vary from unit to unit, and from individual to individual. You know...some folks should simply not try this kind of work. Most folks can be successful however.

2 Re-Capping: Motivations, Considerations, Results

My experience: Recapping generally yields only an incremental improvement in the way a unit sounds, but should significantly increase the life-expectancy of a unit.

Here are your incentives/motivations, so balance them against cost and/or effort:

- I have measured a large number of caps, replaced during a recap. The majority are at or below the low end of their specs, unless they are in a location where they get thermally stressed.
- When 'lytic caps go, as the odds of doing so rises rapidly once their rated life expectancy of around 20 years has been reached or exceeded, they go any one of 3 ways, drift out of tolerance, fail open, or fail short. They all drift, and statistically, failing open or short is about a 50/50 mix.
- If a cap fails open, you may notice, you may not, depending on where it is in the circuit. Generally the fault is easily repaired, with minimal peripheral damage.
- The main risk: If a cap fails short, it can, and generally does, take out significant associated circuitry (ie. semiconductors made out of unobtainium).
- Recapping is cheap, part-wise, averaging $0.35 per cap, but labor is high. A good tech can be counted to be able to replace around 10 caps per hour (including unit disassembly, cap removal, pad cleanup, cap installation, and flux cleanup). Even if the tech only charges $10 per hour, in a unit with 150 caps to replace (not uncommon on gear I work on), the labor really mounts up when it takes 15 hours to do the job. Typical modern labor costs are in excess of $60 per hour. AK restoration artists are not in it for the money (but money is nice), so we generally do not charge anywhere near that rate, but our labor is worth that rate.
- The MOST IMPORTANT aspect of a recap, is the opportunity to refresh all circuit board solder joints. Flow-soldered connections have only about a 30-year life expectancy. In my experience, I have solved more problems caused by old, oxidized, fractured solder joints than by failed/drifted caps. Here is where the real bang for the buck is realized, and MUST NOT be underestimated.

With all of these aspects considered, recapping is really only a viable procedure for upper end gear, unless the gear owner is an avid collector, and wants all of a series in excellent condition, etc.

2.1 Recapping Boiler Plate

Now a bit of boiler-plate recapping info:

Note: Most of the original capacitor series used in these old units are long obsolete. Selecting replacements, from current manufacturers and their series, is also a task requiring a qualified tech. There are many parameters to consider (operating temp, value, value tolerance, life expectancy, effective series resistance, internal losses, physical size, orientation, etc.).

I am a Pioneer specialist (by choice), so, all my work references the Pioneer parts series. This is because my master recapping database is based on Pioneer part numbers.

The problem with most vintage gear (in excess of 25 years old), is the fact that electrolytic caps tend to dry out, since the electrolyte is moist, and must stay that way for proper function. Some caps drift severely, in the lower capacitance direction. Some caps fail open, and simply cease to perform whatever function they were designed in to do. Others that fail, do so by failing short, generally causing catastrophic damage to the unit. You may be enjoying a ticking time-bomb. Some will swell and leak, causing all kinds of corrosion damage to the circuit boards in the area, while others will literally blow up.

Some caps measure OK on a capacitance bridge, but, in the circuit, leak DC, causing noise, bias shifting, instability, etc. I truly recommend re-capping gear you intend to keep and enjoy, or sell to someone you care about.

Re-capping generally requires a complete service manual, with all published supplements, addendums, errata, and modification sheets. Each board is gone through, electrolytic caps are each measured to get their physical dimensions (replacements must fit in the space provided. Not to fear normally, since modern caps tend to be $1/3$ the size of the originals (sometimes causing other problems)). Then the caps are checked to see which Pioneer series they are in (indicated by Pioneer part number). Now you must attempt to determine what characteristics were important to the designers that established a specific Pioneer part number series. Hints come from what cap manufacturer series was used (usually, and hopefully, more than one), "if" you can find the very old data sheets you need (so far all the series I've encountered have been long obsolete), or mfg-to-mfg cross-reference lists. You must also track what kind of circuits the particular Pioneer part number series is used in (coupling, de-coupling, filtering, feedback, etc.). Without the original Pioneer part drawings, you must engage in significant guesswork, supplemented by informed/experienced reverse-engineering.

The next step is to attempt to find modern manufacturers for parts that conform to the design criteria determined in the previous step, followed by locating distributors that handle the replacement parts (in the onesy-twosy quantities you will need), and determine the per unit cost. (Note: I prefer to keep things original. I don't try to second think the original designers, unless the future

owner pays significantly for an upgrade or modification. I do tend to use a bit better part than the original, but not to point of using the very expensive, esoteric, sometimes snake-oil parts. It gets to be a lot of fun when the part you need is not made by anybody in the size and/or voltage you need (like finding low voltage electrolytics in the sub-1uf values). Then you need to substitute a different kind of part altogether.

I then created an overall Pioneer database for electrolytic caps, which I can then draw on for other models down the line, and from which, I create a model-specific database, which shows each cap, on a per-circuit-board basis, with all the associated info (original part number, dimensions, value, working voltage, new mfg part number, distributor part number, price, etc. etc. etc.). The database also contains a table of consolidated data, where all like parts are grouped, used as a purchasing list for the model.

Here are some of my choices for the various types of caps that may need replacement:

- For the low leakage or low noise lytics, I use Xicon LLRL series parts. (Update 5/28/15: The Xicon LLRL series has gone obsolete. For low leakage parts, I now recommend the Nichicon KL series. You might also use the Elna Silmic-II or Nichicon KZ or FG Muse, since the low leakage parts are frequently used for inter-stage coupling.)

- As to the standard 85°C, 20% 'lytics, I prefer to use the Panasonic FM series. When they are not available (possible, since this is a new series for Panasonic), I use the Panasonic FC or the Nichicon PW. They are an incremental upgrade to the originals, in that they are 105°C, lower ESR parts, low tan-theta (relating to internal losses), plus, the Panasonics are pretty, with those gold labels and all.

- For standard 85°C, non-polars, I use Panasonic SU. No upgrade here, but there are fewer choices in this type.

- For the parts "requiring" low ESR, of course I'm using the Panasonic FM and FC, as well as Nichicon PW. No upgrades in this case, except for the temperature tolerance.

When I order the caps for a unit, I usually order enough to do 3 or 4 units, since I usually have at least that many units of any particular model in my inventory, and I like to have the parts I need on hand when it comes time to do them. That way, I also have complete recap kits on hand for incoming restoration commissions. I also usually order at least 2 extra of any particular cap. In that way, my on-hand inventory of caps grows, at minimal cost, which helps to cover the cases where the manual states the need for one value, when a particular board/unit actually has a different value (happens when designs are changed during the production of a particular model).

Recapping is not the panacea for modern man. Recapping is the last thing I do to a unit, other than cosmetic work and final/performance testing. I won't recap a unit, until I have determined that it is fully functional. Recapping is

more for an attempt at adding longevity to the mix. The last thing you want is for a 30-year-old 'lytic to fail short (they also fail open, and drift out of spec). Recapping is not a good "repair" technique (falls in the realm of 'shotgun repair', which I hate).

2.2 Supplemental Recapping Operations

I have done alot of recapping, and I like to test the old ones every now and then, to see what their condition was. In general, I have found that they are not far off, just at or below the capacitance spec for the parts. I have found a few bad ones. What I add, with a recap, is a retouching of every solder joint on the affected circuit boards. Here is where the real problem is, in my experience: old, oxidized, fractured, and cold, joints that have failed. The life expectancy for a wave soldered joint (used in circuit board manufacturing) is right at 30 years. They tend to oxidize, and fracture, etc. I have repaired more problems caused by bad PCB solder joints, than by bad 'lytic caps, by at least an order of magnitude. So, for me, the solder joint retouch is the more important aspect of my recapping service.

When replacing a cap, I have found it to be best to remove the cap, then remove the solder from where the cap was. That way damage to the circuit board traces and pads are minimized. If you try to remove the solder, then get the board to let go of the cap, you will find that there is too much heat, time, and stress on the circuit boards, resulting in lifted solder pads and traces. The best method I have found is as follows:

- Heat one lead/pad and rock the cap out a bit on the heated side. Let the pad cool and repeat with the other lead...working from side to side until the cap comes free.

- Before removing the cap from where it came out, look at the cap and circuit board, to verify that the polarity mark on the silkscreen matches the polarity of the cap. If there is no polarity mark on the board, put one with a Sharpie. If the mark on the board does not match the mark on the cap, you will have to do a bit of reverse-engineering, with the schematic and board layout, to determine which is correct. Don't assume that the way it was installed was right. Mistakes are made in factories all the time. The polarity marks on circuit boards vary. With Pioneer, there is generally a plus sign where the cap's positive terminal goes. Other manufacturers may use a dot, but that will generally indicate the negative terminal of the cap. The caps themselves generally mark the negative lead on the label, and make the positive lead just a bit longer than the negative one.

- Once the old cap has been removed, go back and remove the old solder from the board, where the cap came from. Depending on accessibility, you can use a solder sucker (plunger-type suction tool), or solder wick/braid (braided copper on a roll, impregnated with a bit of rosin flux). I usually use the wick for hard to reach places only.

- Form the leads of the new cap to fit the holes (so there will be some strain relief, and there will be no stress on the new joints. Then install the new cap, and solder, leaving a nice clean, well-formed, slightly concave fillet ("the bigger the blob, the better the job" is definitely a bogus concept). Trim the leads, so that there is just the slightest amount of lead left extending out of the solder joint. Do not cut into the solder joint.

When all the caps (and other parts) have been resoldered, use a soft toothbrush and alcohol (Techspray 1610-P or Chemtronics Flux-Off NR 2000) and clean off all the new and old flux from the board. This will take a while, since the old stuff tends to be abundant, and doesn't dissolve as easily as it would have if cleaned off when fresh. When doing this, make sure that you do not drip off of the board into coils and pots (etc.) or other boards or into any mechanism. The flux in solution will not be kind when the alcohol carrier dries. I usually put a couple of layers of paper towel to catch the drippings.

While you have a board loose, it would behoove you to desolder and remove any heat-sunk drivers, clean off the old heatsink grease, and apply new heatsink grease (I use Dow Corning 340). Be very careful to reassemble exactly as they were assembled. Many drivers are electrically isolated from the heatsinks, using mylar isolators or some other method. If you don't put them back together the way they were, you will let the magic smoke out when you apply power later. Putting fresh heatsink grease on will help to keep your old parts cool so they will last longer. Old, dry, flakey heatsink compound does not do its job well.

Note: Styrol (polystyrene) capacitors are extremely sensistive to heat. They cannot tolerate temperatures above 85 degC, and will be damaged if subjected to higher temps. Soldering involves temperatures in excess of 200 degC. You must clip a heatsink clip between the capacitor and the solder joint when retouching joints associated with styrol caps. To be safe, unless a magnified visual inspection of a solder joint, related to a styrol cap, reveals the need for reflowing (oxidized, fractured, etc.), I generally mark the solder joints in close proximity, on the same trace, with a red sharpie. This is so I will not hit them with a soldering iron during the solder joint retouch operation performed on the board, once all the 'lytics have been replaced on it. The sharpie ink is usually removed when I clean off all the old flux from the board, after solder retouch. The figure 1 shows a couple of styrol caps, so you can recognize them...

Part II
Restore process

3 Initial Preparation

Here, we start getting ready to dig in...

1. Remove the bonnet, by removing the 4 screws on each side.

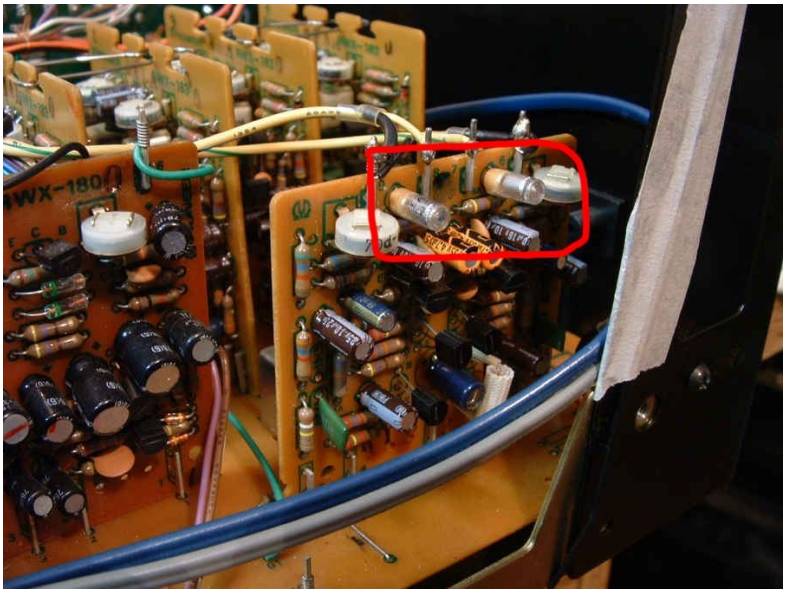


Figure 1: Styrol Caps

Figure 2: Back Panel Screws

2. Remove the back panel, by removing the 4 screws indicated in figure 2.

Here are some pictures of what's inside:

3.0.1 Bottom Cover Removal

1. Remove both feet, by alternately hanging the unit off the bench and remove the foot that is hanging off (*Do not lay the unit down on the back of the feet, as they WILL break*).

2. Remove the 6 screws (indicated in figure 4) and remove the bottom plate

Figure 5 shows the bottom of the unit bith the bottom plate removed.

3.0.2 Front Panel Removal

1. Remove 'Input', 'Output', and 'Speed Pitch' knobs.

2. Remove the 3 screws (indicated in figure 6) securing the upper faceplate to the frame, then pivot the faceplate forward on its bottom edge, until the faceplate clears the reel tables, and lift upper faceplate off.

3. Remove the 3 screws securing bottom edge of the lower faceplate (indicated in figure 6), and the 3 screws securing the upper edge of the lower faceplate (indicated in figure 7).

4. Push up on the pinch rollers, to clear the lower faceplate, and carefully maneuver the lower faceplate off, as in figure 8.

4 Tension roller rebuild

I have yet to see an RT-909 that does not need some serious work done on the tension rollers. There is alot more to these beauties than meets the eye, and they are a great contributor to the excellent flutter specs on this model. None of the units I have seen have tension rollers that worked as they were designed to. Generally, they either snap back and forth with no damping, or the move back and forth so sluggishly they cannot possibly do their jobs properly. It will likely take several posts to get one tension roller done, and we will only illustrate the left one, since the right one is simply the mirror image of the left one.

Note: Even though I am only illustrating one roller, you should do both of them in parallel. This is because we will be swapping parts between them, for reasons I will explain later.

This is the left roller fully assembled:

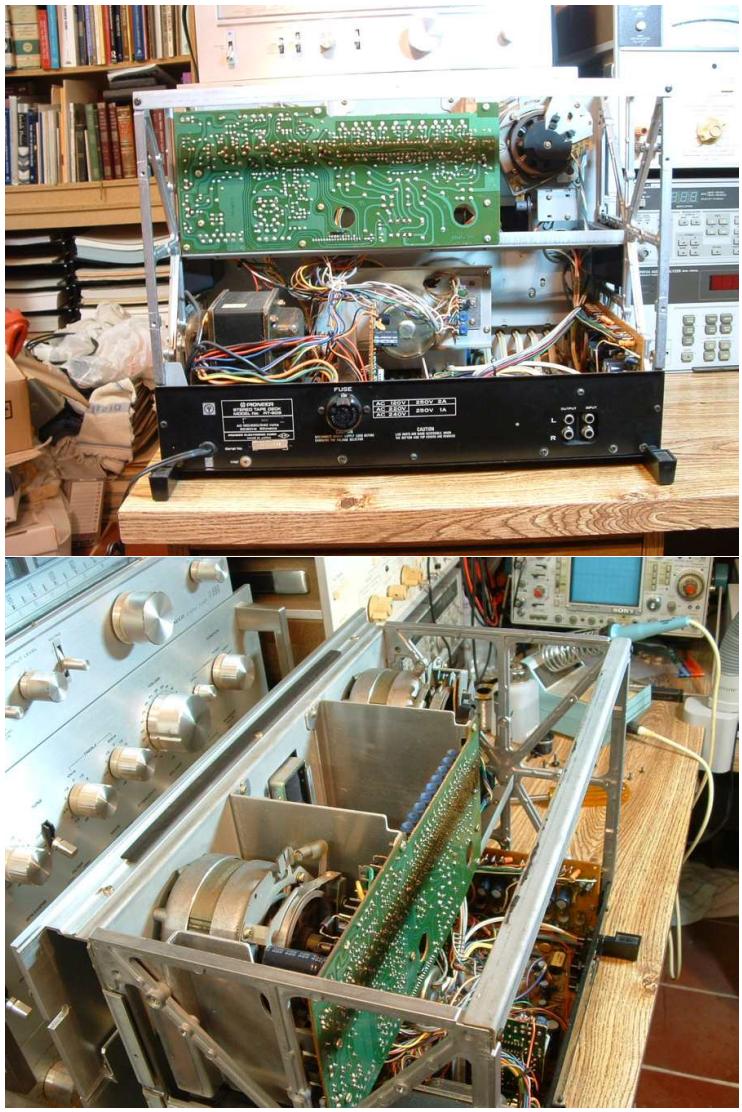


Figure 3: Inside views

Figure 4: Bottom plate screws

Figure 5: Bottom of the unit

Figure 6: Upper/lower faceplate screws

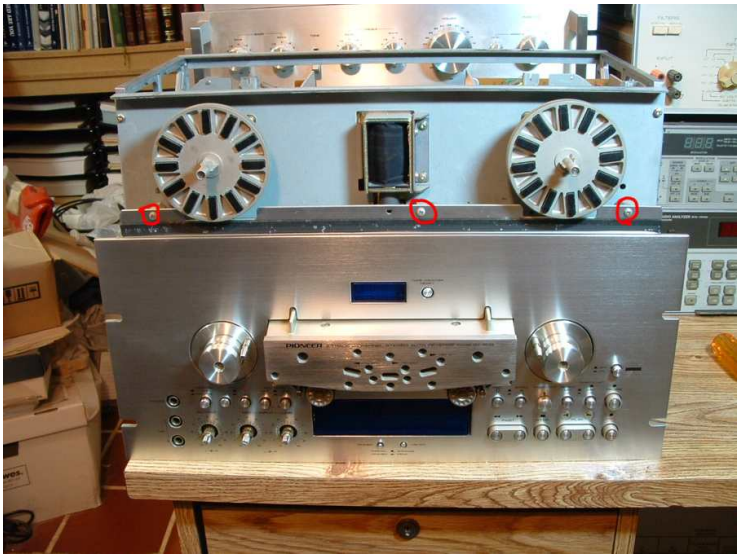
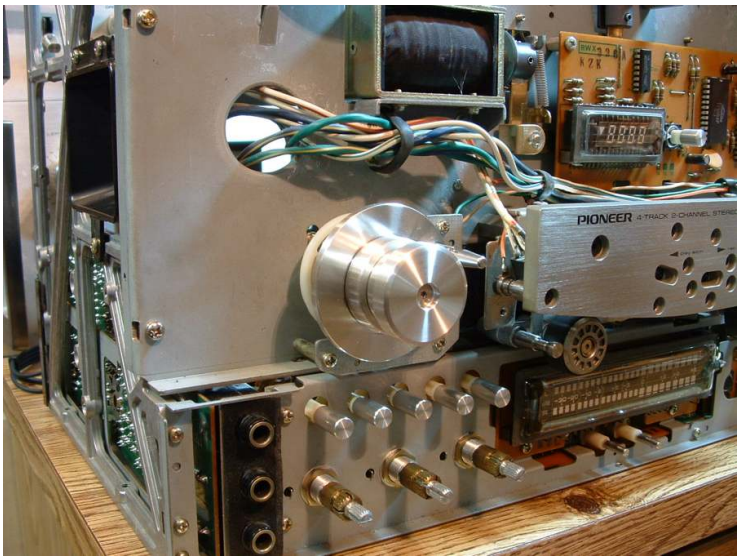


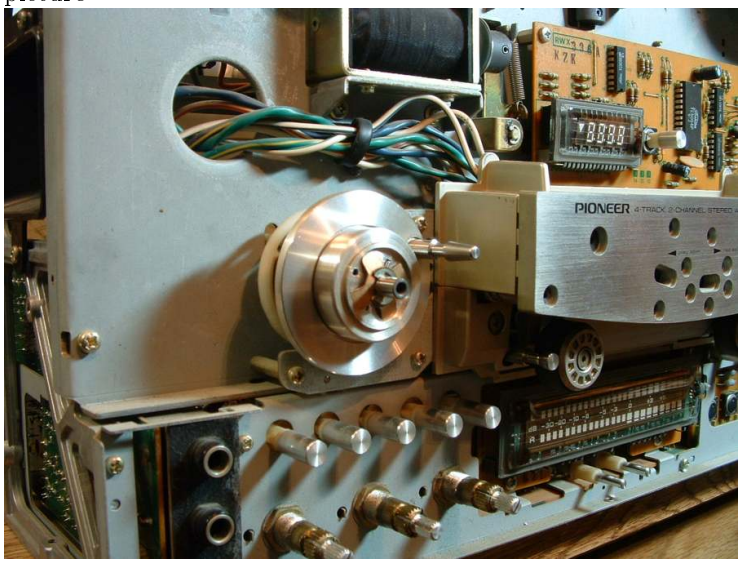
Figure 7: Upper edge of the lower faceplate

Figure 8: Faceplate removed



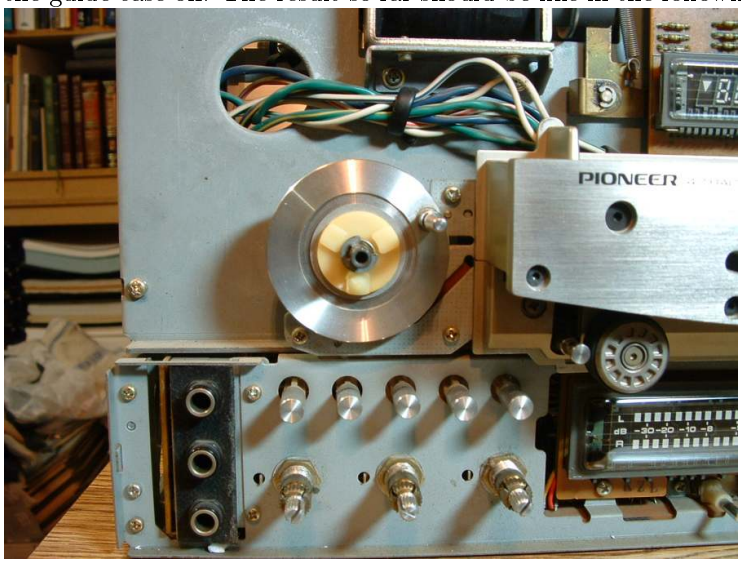
1. Remove the center hex screw (securing the end cap to the roller) with a 2.5mm hex-key. (Note: be careful to capture the nylon washer that is under the end cap).

2. Remove the roller segment, and the nylon washer beneath it (be careful not to lose the nylon washer). The results, so far, are seen in the following picture



3. Remove the guide case as follows...Remove the c-clip (be careful, it will try to fly). Remove the roller spring-washer (note its orientation). Put your hand under the tension roller assy to catch the parallel pin, which

will fall out as the guide case is slid off. Slide guide case off. Be sure to note the nylon locating pin from the ball holder beneath, before sliding the guide case off. The result so far should be like in the following picture



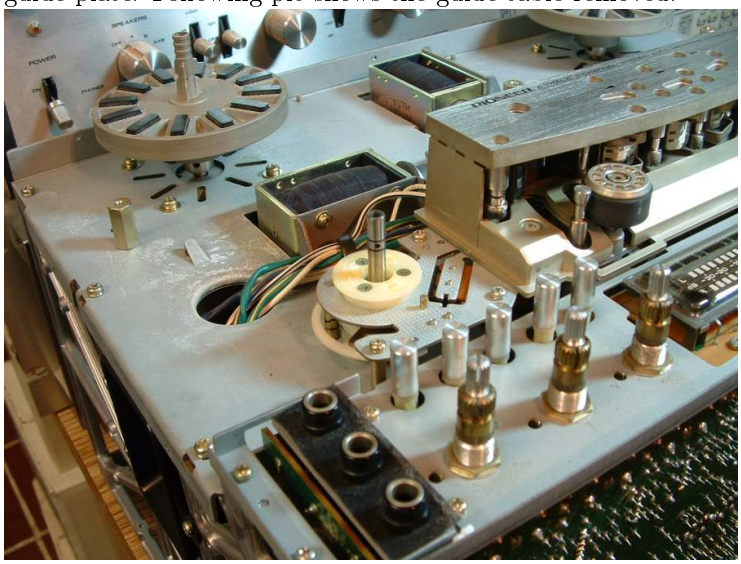
4. Prepare to be very careful (lots of parts to jump or roll off). Lay the unit on its back for maximum control, and put a piece of tape around the outer edge of the tension roller assy, to act as a fence for small balls about to be released.

5. Remove the nylon ball holder as follows: Remove the c-clip, while holding the spring and c-clip captive (both will try to jump away from you as the c-clip comes loose. Take away the c-clip, and allow the spring to gently relax, then remove the spring. Carefully, lift the ball holder, looking under it for nylon ball(s) that may be lying on the guide plate. Get the loose balls 1st, the capture the balls that remain in the ball holder (3 balls total). Note: Do NOT damage the soft surface of the balls, since they are only made of nylon.

6. Carefully clean the old waxy lube from the balls and from the ball holder pockets. Put the balls in a secure place, so they cannot roll away or get knocked off on the floor (they are worth from $300 - $400).

7. Clean off the old lube from the ball path on the guide table assy. Following pic shows the exposed guide table...

8. Remove the guide table as follows: take note how the tension arm return spring is connected, then disconnect one end. Gently lift up the guide plate, looking beneath it, to see what will happen to lower nylon balls. Make sure all 3 balls will remain in the lower ball holder, and lift off the guide plate. Following pic shows the guide table removed:



9. Remove and store the spring, then clean off the old lube from the lower ball path on the guide plate.

10. This guide plate is to be swapped with the one from the right tension roller, which is identical to this one. The swapping is to have the effect

of rotating the tape guide, so a fresh, unworn surface is presented to the tape that passes over the guide. Each tension roller guide will be worn on one side, and swapping the guide plates left and right will put the worn guide faces away from the tape when the rollers are reassembled. Swap the guide plates now, so you will not forget. Also, mark it with a sharpie on the back side, so there is no question which side it came from.

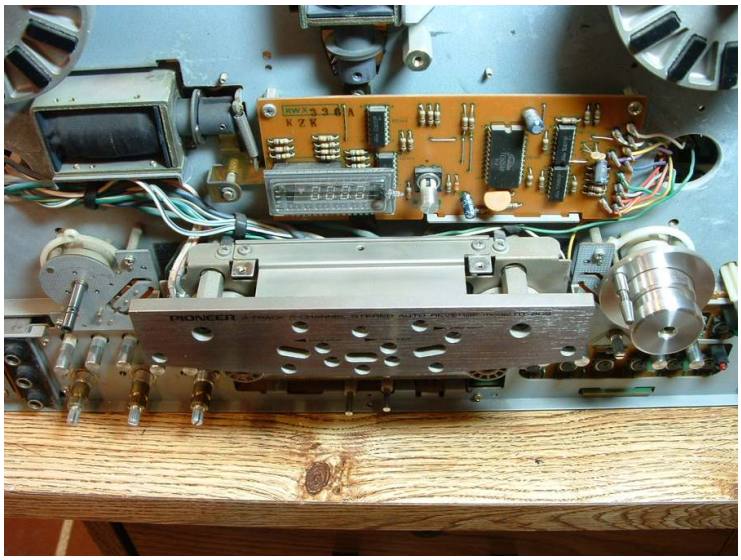
11. Carefully remove, clean, and stow the 3 nylon balls.

12. Remove the 3 countersunk screws retaining the ball tray, remove the ball tray and clean the old lube off of it. Next pic shows the results so far:

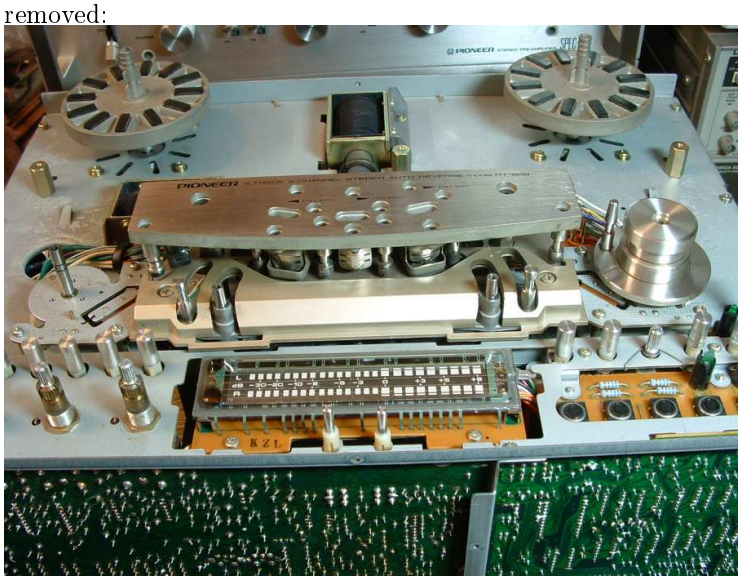
4.1 Head base access

Now, in order to obtain the room necessary to get the remains of the tension roller removed, we will need to do some supplemental disassembly...

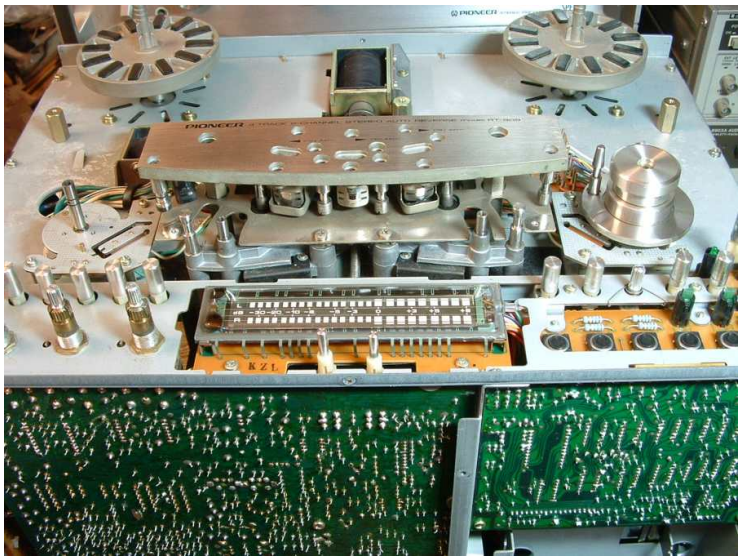
1. Remove the upper head housing as follows: Stand the unit up. Remove the 2 screws securing the upper head housing. Remove the counter reset button. Lift off the upper head housing & reinstall the counter reset button. Picture shows the upper head housing removed:



2. Remove the pinch rollers: Lay the unit back down. Remove the hex screw retaining the pinch roller, and capture the roller collar (special washer under screw), and the polyethylene washer under the collar. Be careful. There are 2 polyethylene washers associated with each pinch roller (one on the outside and one on the inside), and these are frequently lost and are no longer available. Lift off the pinch roller and capture the polyethylene washer directly under it. Picture shows the unit with the pinch rollers removed:



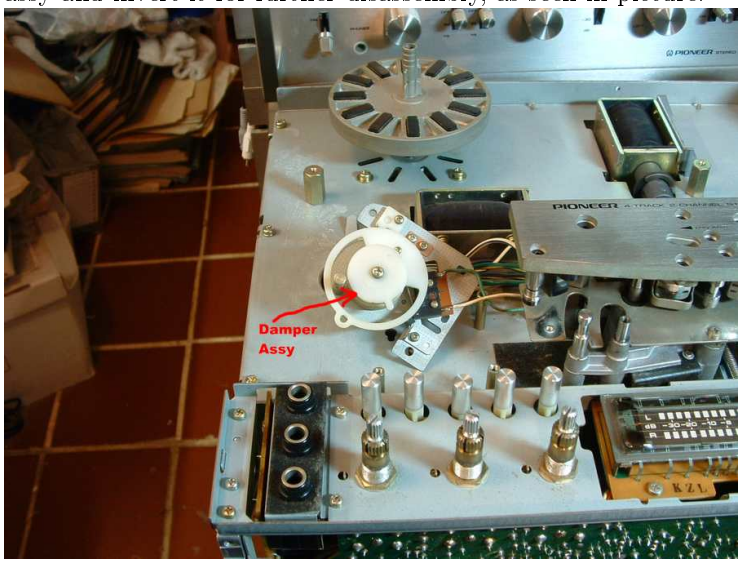
3. Remove the 2 screws retaining the lower head housing and lift it off. Picture shows the lower head housing removed:



4.2 Left Tension roller rebuild (cont'd)

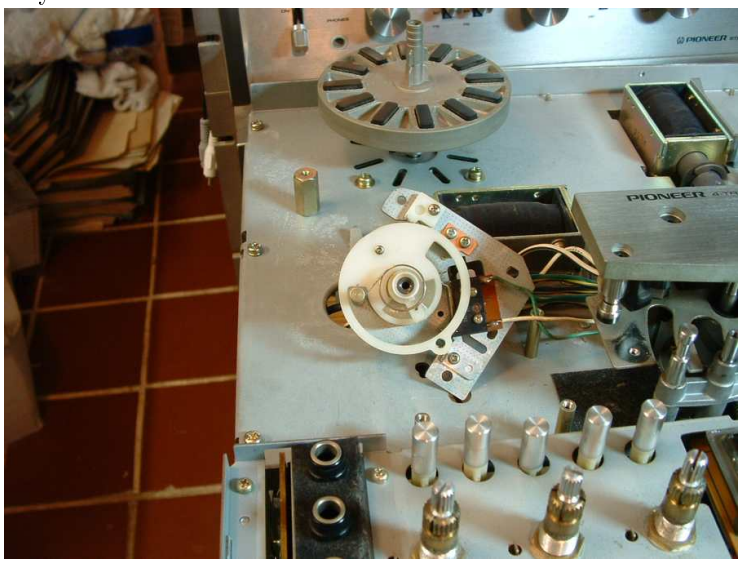
Now we can finish rebuilding the tension roller(s)...

1. Remove the 3 screws retaining the roller stay assy, then lift off the stay assy and invert it for further disassembly, as seen in picture:



2. Note the orientation of the damper assy (indicated in picture above), with respect to the rest of the remaining tension roller assy, then remove the single screw retaining it and carefully lift it off. Picture shows the damper

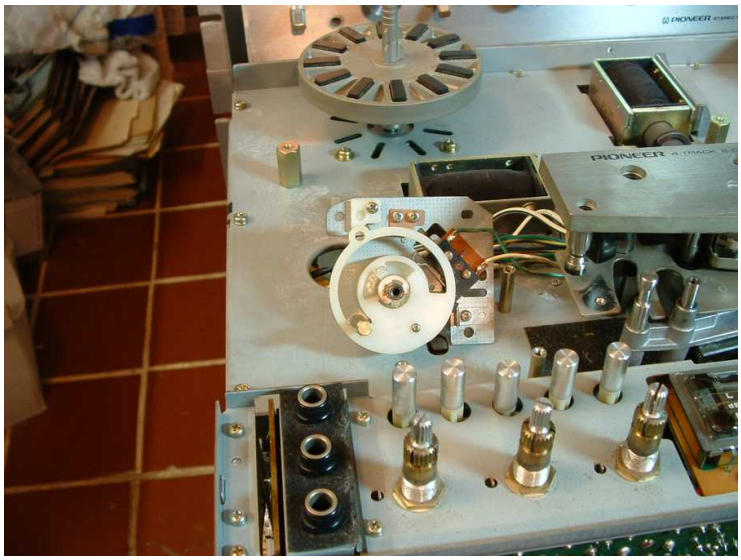
assy removed:



3. Pull the 2 halves of the damper assy apart and clean out all the old silicone damping fluid and old lube.

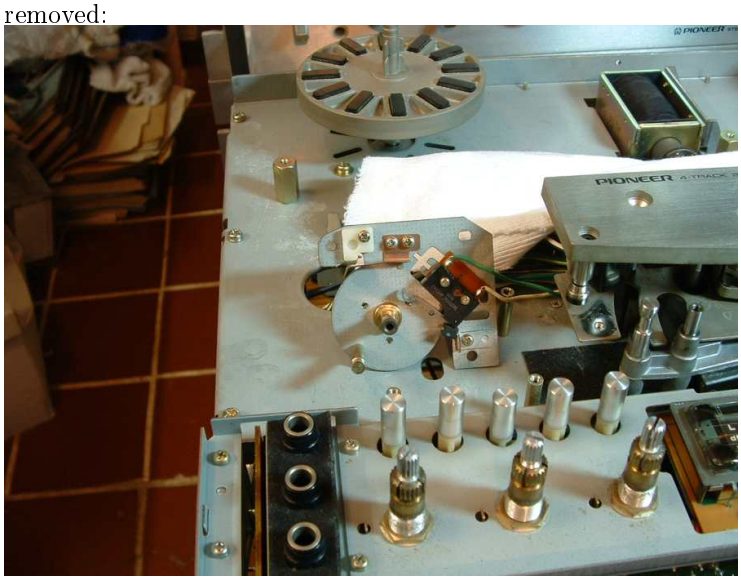
4. Put 5 drops of 10,000 cSt (centi-Stokes, a measure of viscosity) silicone damping fluid in the damper assy, press the 2 halves back together and set the completed damper assy to the side. The damping fluid is available from hobby shops, dealing in parts for RC race cars, in the guise of "Diff" (differential) fluid. The damping fluid is placed at equidistant intervals on the face of one half. When the two halves are put back (face to face), the damping fluid is sandwiched between the two halves.

5. Take note of the orientation of the damper spring, then unhook it from the post, and remove the damper plate with the spring attached (be careful to capture the clear plastic washer beneath it). Picture shows the damper plate and spring removed:



6. Clean off all old lube and leaked damping fluid from the damper plate, spring and plastic washer.

7. Remove the c-clip retaining the shutoff cam (be sure to capture the plastic washer under the c-clip), and remove the shutoff cam (be sure to capture the plastic washer under the shutoff cam). Picture shows the shutoff cam removed:



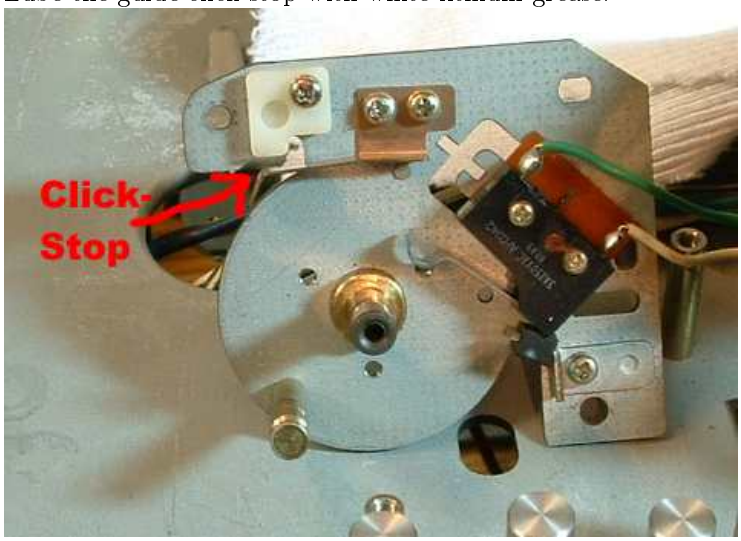
8. Clean off all old lube and damping fluid from the shutoff cam, c-clip, and 2 plastic washers.

9. Remove and replace the shutoff switch (OMRON SS-5GL13-F, 4A, 16 gf, Sim Roller). Please note that the shutoff switch switches 250mA+, so a standard 100mA sim roller micro-switch is not suitable. Also the switch used must be a light actuating force switch (20 gf or less).

10. Lube and reinstall the shutoff cam: put white lithium grease on 1st plastic washer and install it on the shaft. Lube shut-off cam surface (actuates the switch), and shaft hole with white lithium grease and install the shutoff cam. Lube both sides of the upper plastic washer with white lithium grease and install, then retain the cam with its c-clip.

11. Rotate the cam back and forth to ensure that it actuates the switch at both rotation limits and releases the switch in between the limits.

12. Lube the guide click-stop with white lithium grease:



13. Lube the shaft hole of the damper plate and spring, then install them.

14. Install damper assy (oriented as it originally was, relative to the damper plate, and stay assy, and secure with its screw (not too tight, old nylon can split).

15. Verify correct operation of the completed damper assy: Rotate the shutoff cam to shutoff position (not click-stop position). Wait 5 secs. Slowly rotate the shutoff cam away from its shutoff position (towards click-stop). Verify that the 1st 30 or so degrees are without resistance. Verify rest of rotation is gently resisted by the damper assy. Slowly rotate the shutoff cam back toward the shutoff position (away from click-stop), and verify the damper offers no resistance at all, and then verify that the damper assy follows the rotation slowly, and comes to its rest in about 2-3 secs. This check will be repeated when the tension roller is completely reassembled.

16. Rotate the assembly to upright position and secure it in place (3 screws).

17. Install and secure (3 screws) lower ball tray (don't screw down too tight or old nylon will crack).

18. Fill ball pockets of lower ball tray with white lithium grease, then press the 3 nylon balls in to their pockets (grease "should" overflow). The grease will retain the balls until assembly is complete.

19. Install the guide plate as follows: Lube (white lithium grease) shaft hole in the guide plate from the right tension roller assy (remember we swapped them earlier), and slide it on the shaft. Make sure that the back of the tape guide fits into the hole in the shutoff cam, below it. Re-attach the return spring.

20. Fill the ball sockets in the upper ball holder with white lithium grease, then press each of the 3 nylon balls into their sockets (grease should overflow, and grease should retain the balls until assembly is complete).

21. Install the upper ball holder and its spring and retain them with their c-clip (be careful, jumping parts here).

22. Install the guide case as follows: Slip the parallel pin into its hole and center it. Slide the guide case on, while rotating the ball holder below until its pin fits into its hole in the guide case. Put on the roller spring washer, and secure with its c-clip.

23. Install the roller segment as follows: Slip the plastic washer on the shaft, followed by the roller segment, and the other plastic washer.

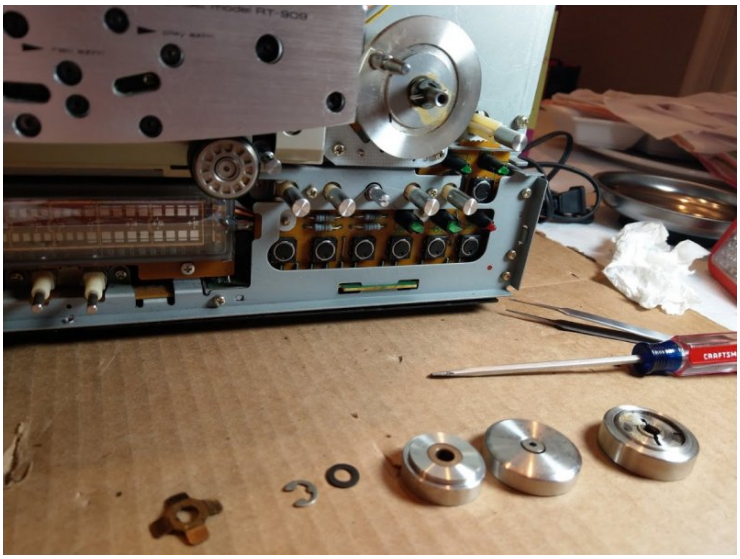
24. Install the end-cap and secure it with its single screw.

25. Verify correct operation of the completed damper assy: Verify that the guide plate is held against its rest by return spring pressure. Slowly rotate the guide-plate away from its rest. Verify that the 1st 30 or so degrees are without resistance. Verify rest of rotation is gently resisted by the damper assy. Continue to rotate the guide plate to its limit, and verify the click-stop retains it in its open position. Free the guide plate from the click-stop, and release it. Verify that it quickly snaps back to its rest position, without resistance from the damper assy. Verify that the damper plate slowly comes to its rest (on the back side of the tension roller assy), in 2-3 sec.

26. Repeat entire process for the right tension roller assy (remember that the guide table from the left tension roller is to be installed on the right tension roller, to present a fresh guide face to the passing tape).

4.3 Later models assy

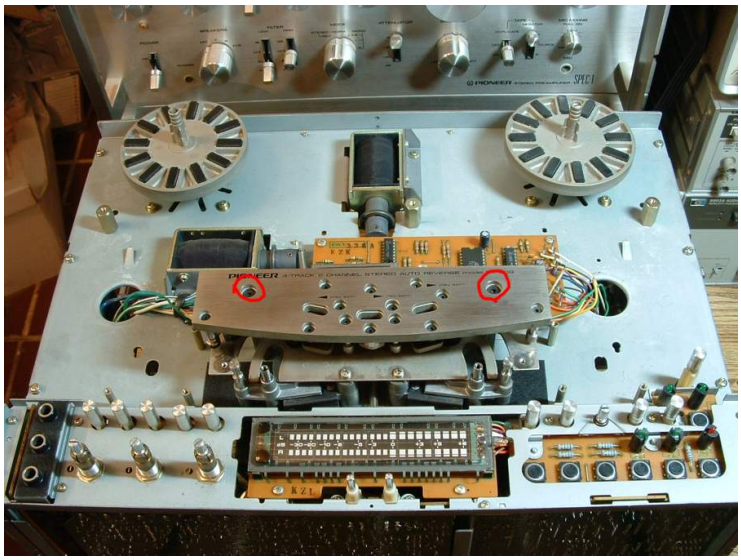
There are 2 versions of RT-909 tension rollers. In latter versions the ball holder and 3 nylon balls are missing:



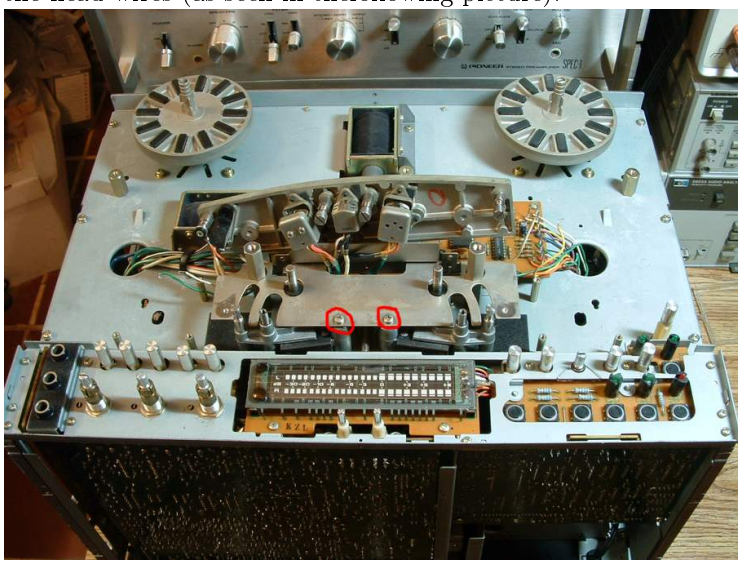
5 Transport Linkage Access & work

Once the operation of the newly rebuilt tension rollers has been verified, its time to work on the transport linkage...

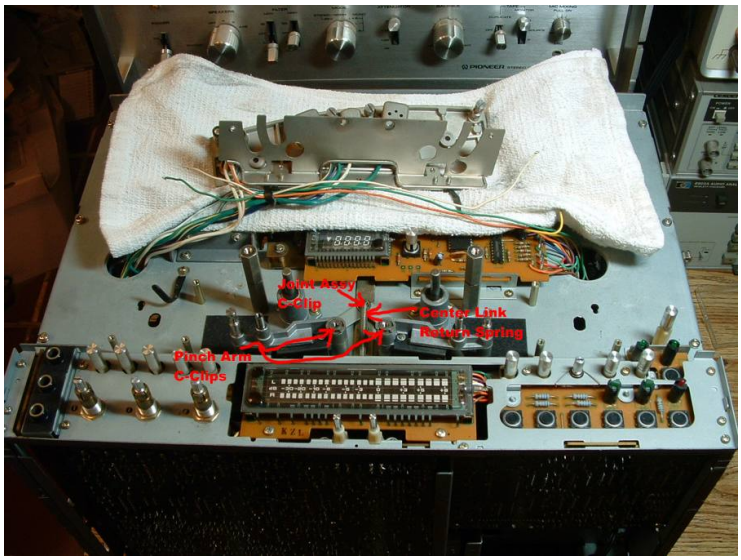
1. Remove the 3 screws securing the left tension roller, record the wiring of the shutoff switch, remove the wires from the shutoff switch, remove the tension roller assy. Repeat for the right tension roller assy (Picture shows the unit with the tension roller assys removed).



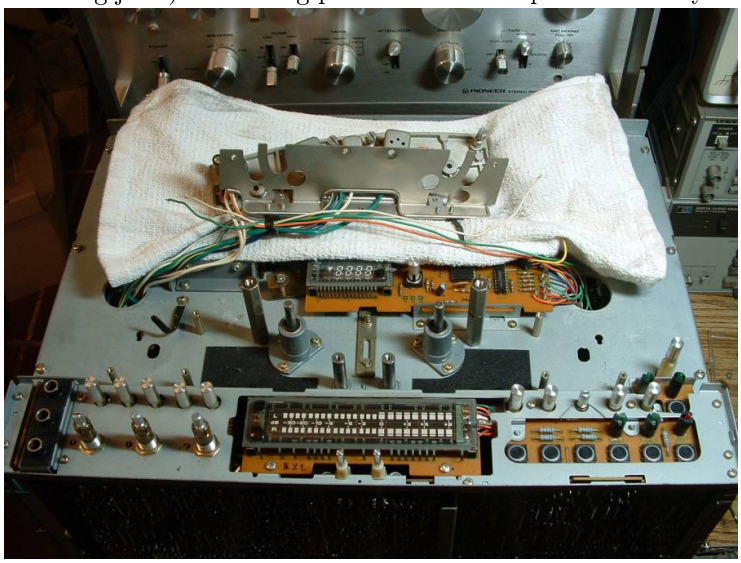
2. Remove the 2 countersunk (2.5mm) hex screws (indicated in the picture above) securing the head base assy, and hinge the head base assy back on the head wires (as seen in thefollowing picture):



3. Remove the 2 screws (indicated in the picture above) securing the shield plate. Put down padding to protect the face of the head base assy, then lay the head base and shield plate out of the way (as seen in the following):



4. Remove c-clip and nylon washer (indicated in the picture above) retaining the left pinch arm assy. Repeat for right pinch arm assy. Remove center-link return spring (indicated in the picture above). Remove c-clip & nylon washer (indicated in the picture above) securing the retaining joint assy (notice right over left order). Lift off left and right pinch arm assys (watch out to capture the nylon washers under each pinch arm and under the retaining joint). Following picture shows the pinch arm assys removed:



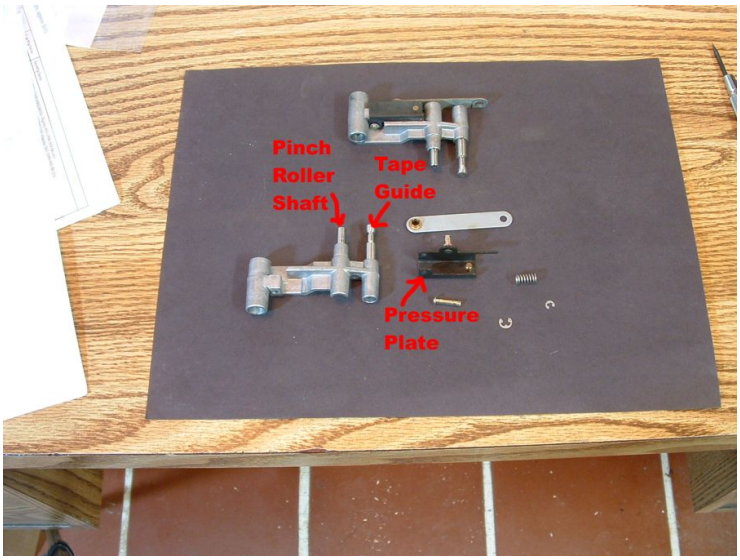


Figure 9: Pinch arm assemblys and component parts

5.1 Pinch arm works

Here a bit of careful firmness is necessary, since the tape guide associated with each pinch arm is not secured with a screw, but still needs to be rotated, to expose a fresh, unworn face to the passing tape...

1. Disassemble the right pinch arm assy & clean off all the old lube (be careful to capture the spring, it will want to jump and hide). Repeat with left pinch arm assy.

2. With a Sharpie, put a mark on the right pinch arm's tape guide, to show original orientation. Repeat with left pinch arm tape guide.

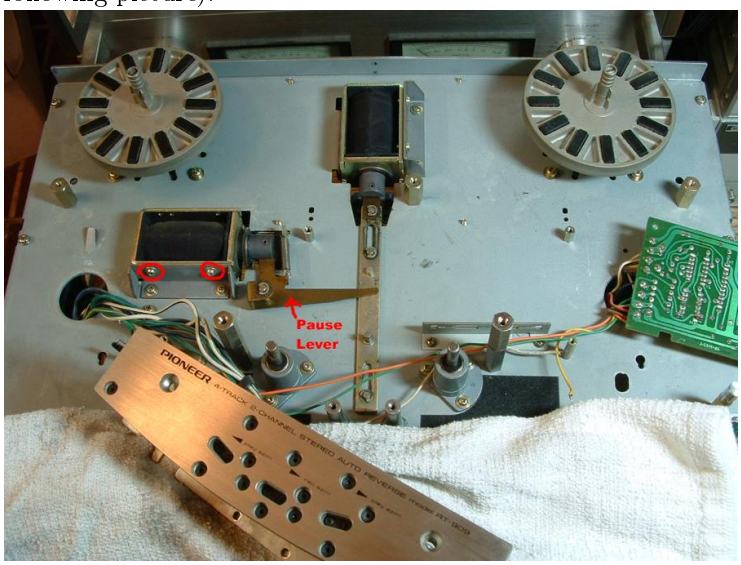
3. Drill a 1/4" hole in the end of a short piece of 2x4 stock, close enough to the end so that the capstan shaft of the pinch arm is clear when the tape guide is placed in the hole. Carefully, but firmly, drive the tape guide out of the right pinch arm assy (be sure to drive in a direction that is exactly in line with the center line of the tape guide). Rotate the tape guide 180 deg, and carefully drive it back in (use a mallet, not a metal hammer). Repeat for the left pinch pinch arm assy.

4. Lube the left pinch roller pressure plate hinge pin shaft & hole, then, reassemble the left pinch arm. Repeat for the right pinch arm assy.

5.2 Pinch Linkage Work

Now to clean and lube the linkage that actuates the pinch rollers...

1. Move the anti-scratch padding to cover the VU meters, and move the head base and shield plate there.
2. Remove 2 screws securing counter assy, and hinge the counter assy on its wires to expose the center link assy and pause lever (as seen in the following picture):



3. Remove the spring, pause solenoid upper screws & c-clip retaining the pause lever (as indicated in pic 1), then maneuver the pause solenoid until the pause lever comes free.
4. Remove the upper screws securing the pinch solenoid (as done with pause solenoid).
5. Remove the 2 c-clips and nylon washers retaining the center-link, then lift the pinch solenoid and pull plunger to free center-link.
6. Remove the c-clip securing the plunger to the center-link.
7. Clean all pinch roller linkage parts, lube all contact points with white lithium grease, and reassemble.
8. Re-install pinch arms and center link joint, lubing all contact points as well as pinch arm shafts with white lithium grease.
9. Secure both ends of pause lever spring and center link spring with contact cement.

5.3 Rotating tape guides

Before securing the head base back in place, it is time to rotate the last tape guides, to expose unworn faces to the passing tape...

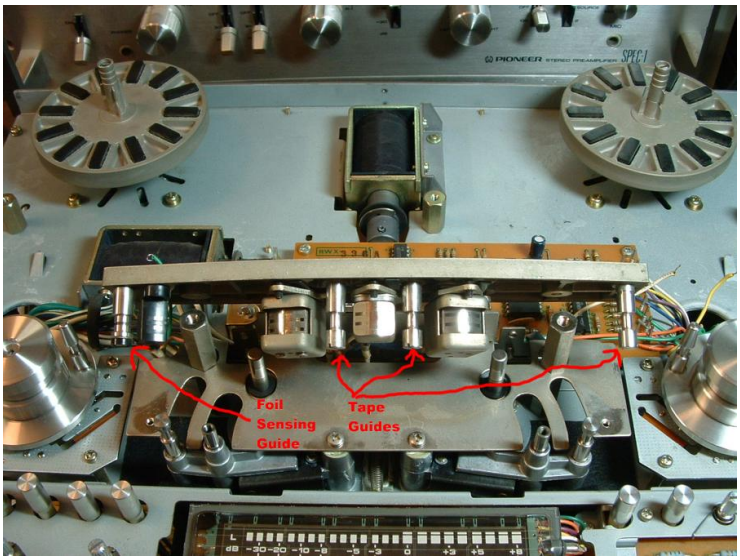


Figure 10: Tape guides

1. Mark each tape guide in the head base assy, as well as the foil sensing guide, showing original orientation.

2. Loosen the (2.0mm) hex screw securing each tape guide, and rotate the guide to expose a fresh, unworn surface to the passing tape, and re-tighten the hex screw.

3. Loosen the screw securing the wire to the foil sensing guide, then loosen the (2.0mm) hex screw securing the foil sensing guide to the head base, and rotate the foil sensing guide to expose a fresh, unworn surface to the passing tape, and re-tighten the hex screw. Ensure that the sensing wire is oriented out of the way (to the rear) of the shrouds and other hardware, and will not short to any of it when reassembled, tighten the screw securing the wire to the foil sensing guide.

6 Head Work

RT-909 heads all have wear grooves in them, from the tape passing over them. If you are going to change the alignment or position of the heads at all, you MUST have the wear grooves removed. If you do not, the sharp edges of the wear grooves will damage every tape that passes over the heads from then on. Even if the heads are not moved, the wear grooves will cut, curl, or shear the edges of any tape that passes over them, causing incremental damage each time a tape is played.

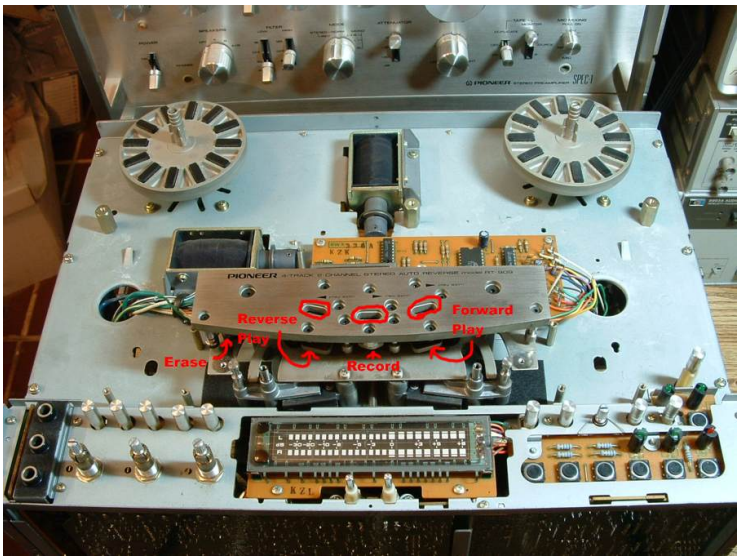


Figure 11: Heads

Worn heads can be either replaced (RT-909 heads are still available from Pioneer, but are over $100 each), or re-lapped, where the wear grooves are ground away, and the head faces are reshaped to provide optimal contact with the passing tape. I cannot over-emphasize how important this contact is. I get my head re-lapping work done by JRF Magnetic Sciences (http://www.jrfmagnetics.com/). Their normal clientele are professional recording houses, with large multi-track heads to rework, but JRF will not hesitate to do a professional job for you. You can even send them the entire head base assy, and they can use special, high resolution optics to align all the heads and guides to perfection so the assembly will be plug and play when it returns.

1. Check for a wear groove in the erase head, with your fingernail. Generally, these heads do not wear like the other 3 heads, but if you detect a wear groove, the erase head will need to be re-lapped along with the others. Otherwise, leave it installed, as is. If you must remove it, it is retained by 2 screws, to the underside of the head base assy.

2. Remove the rear head shield plate (2 screws). Then, record the wiring of each head (very important). Draw a picture, showing the wire colors, and relationship to head base plate.

3. 3. Remove each head, removing only the 2 screws for each head (circled wells in figure 11). Do not change the rotation of any other screw associated with the heads, as they establish the head alignment, and will provide a good alignment starting point for each head, when they return.

4. Note that the record head has an extra spacer between the head plate and the head, be sure to capture it, and note its orientation.

5. Note that the reverse play head is upside-down, compared to the other heads, with an extra screw plate, and the head is screwed to the shield while the shield is screwed to the head plate. Also an extra un-threaded spacer is between where the head screws to the shield. Be sure to capture all the extra hardware. Draw a picture of how the various components are oriented and located.

6. Be sure to scratch an indication of where the heads were (FWD, REV, REC) on both "sides" of each head. There is no part number on the heads to uniquely identify them, and they are different. Both sides, because JRF will put a "re-lap" label on each head, indicating their work.

7. When the heads return, re-install them, then secure the head shield plate, and the head base assy in place.

8. Reinstall the rear head shield plate, lower head housing, and upper head housing.

9. Put a couple of drops of synthetic gear lube on each pinch roller shaft, then install new pinch rollers (http://parts.pioneerelectronics.com/model.asp?modelNum=RT-909)[1], being sure to install a polyethylene washer on each side of the pinch roller. Remember to snap the roller face off of the old roller and snap it on the new roller. Ensure that the pinch rollers roll free.

6.1 Pinch roller adjustment

What you do is to manually raise the rollers to contact the capstans. Verify that both rollers contact the capstans at the same time (roller diameter is in question if not). Measure the play left until the capstan soleniod is bottomed out. That is the solenoid gap we are talking about adjusting. It is not critical, but get it as close to center of the range as possible.

The pinch roller pressure is actually governed by little springs in the pinch roller arms, and is not really adjustable, except by changing the springs. If your gap is good and your springs are good, you will have good roller pressure. The roller pressure measurement is a verification, not feedback on adjustment. The pressure will either be right or not. If not, bad springs, or sticky lube in the mechanism.

You adjust the solenoid gap by moving the solenoid, itself. Make sure that the solenoid remains square to its plunger travel, also.

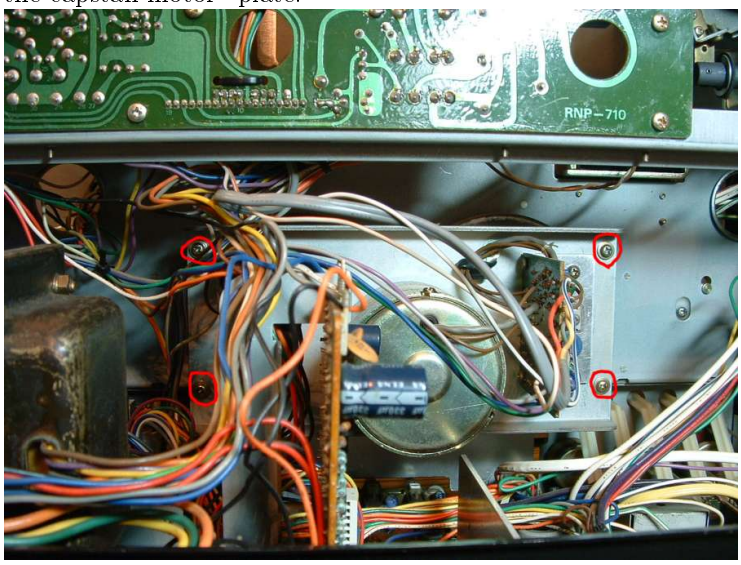
Wow is an indication of off-center, or out-of-true rollers, or capstan belt that is too tight, too thin, or streched, or a capstan motor with a bent shaft or someother damage. Insufficient roller pressure will usually manifest by overall tape slow-down towards the end of tape play. Adjust your gap, verify synchronous roller-to-capstan contact, and see what issue(s) remain...

[1] No more parts available.

7 Capstan drive work

7.1 Capstan disassembly

1. Stand the unit up and rotate it so the rear can be accessed. Picture shows the capstan motor[2] plate:



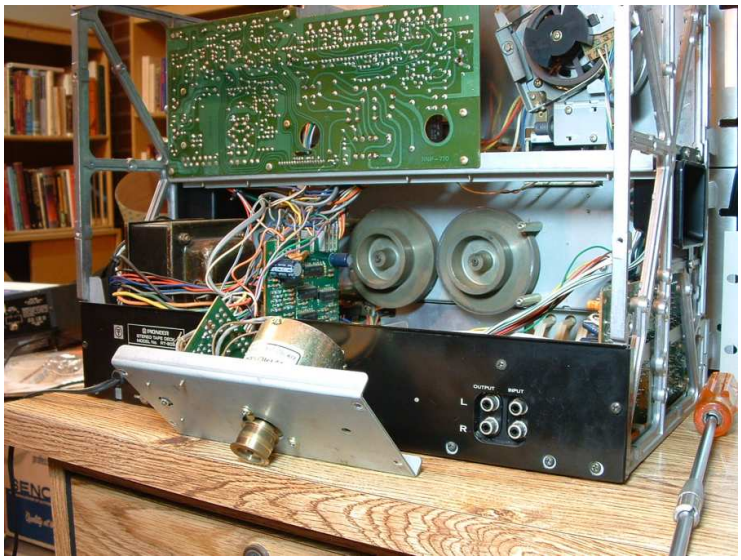
2. Stretch wide masking tape across the open space, sticky side up, at the bottom of the capstan motor plate, to catch loose parts which could drop out when the motor plate is removed.

3. Remove the 4 screws (indicated in picture above) securing the capstan motor plate to its standoffs, then, draw the motor plate back carefully, watching to capture any parts that my drop out (specif, the nylon thrust bearing balls, located in the back end of each capstan shaft (2 balls total). Generally, the balls are retained by lube in the end of the shafts, but they could fall out and get lost. If you lose these, you have a very expensive paperweight, since no one makes 4.0mm nylon balls (I have a fix, if lost, but that is a topic for another thread). --- 4mm Delrin balls are available from McMaster-Carr (P/N: 9614K73) Note: The screw locker that Pioneer originally put on the heads of these 4 screws works better than you would think. Chip it all off, or you might strip out the heads of the screws, trying to get them to let go.

4. Capture the nylon bearing balls and secure them in a plastic bag for later.

5. Hang the motor plate aside by the motor wires. The following picture shows the capstan motor plate removed:

[2]The capstan motor from a Teac X-3 machine is an exact match, so we now have an active source for these motors from Teac, although expensive.

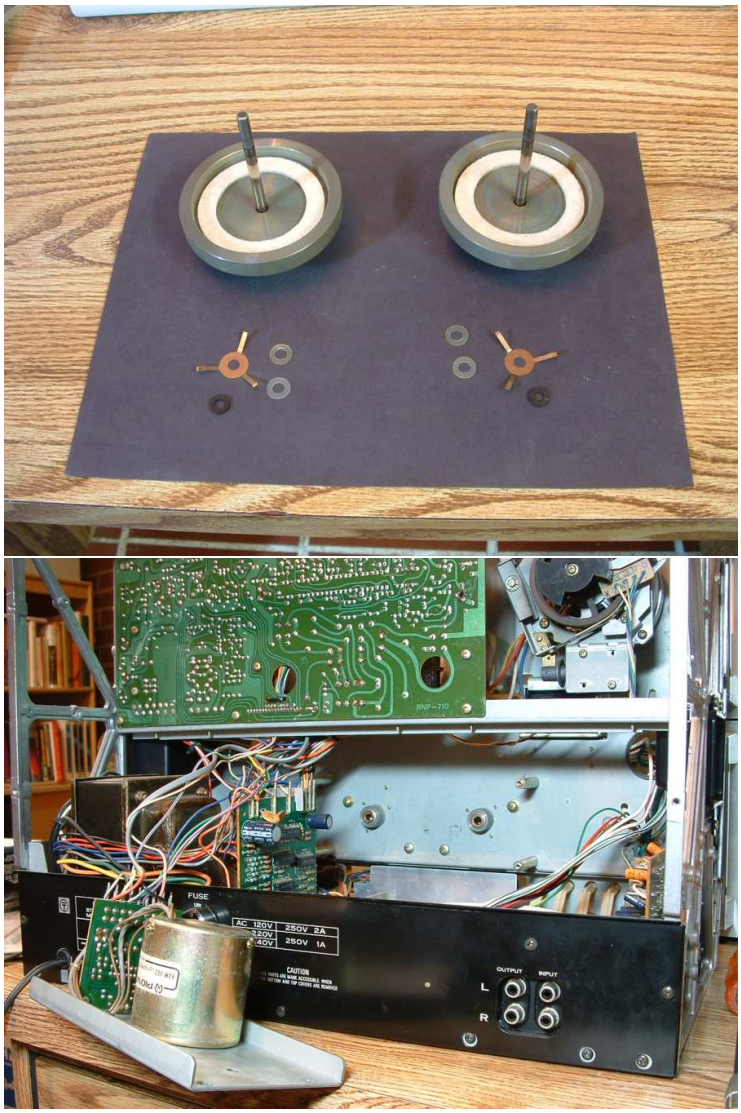


6. Remove the old belt.

7. Rotate the unit to access the front side, and remove the rubber oil thrower washer from the front of each capstan shaft. The rubber washer keeps capstan lube from getting to the portion of the capstan shaft that comes in contact with the tape It also keeps the chemical that you clean the capstans with from getting into the front capstan bushing (maybe more important. (Update 5/28/15: Be careful here, since the rubber thrower washers may have hardened over the years. They may crack and break when you try to remove them (They live in a slot in the capstan shaft). If they do break, you can replace them with neoprene washers (exact: 5mm ID, 10mm OD; in a pinch the common 3/16" ID, 1/2" OD washers commonly available will do, but you will have to trim down the OD so it will clear the capstan holes in the lower head shield plate).

8. Rotate the unit back to access the rear.

9. Using a Sharpie, mark each capstan flywheel, as to whether it is on the left or right. Then, carefully draw each capstan out, being careful to capture the hardware on the inside of each flywheel (thrust spring with a nylon washer on each side of it). Following pictures show the capstans and their various hardware and the unit with the capstans removed:



10. Using a firm q-tip on a wooden stick, moistened with sewing machine oil, clean the old lube from the front and rear bushings of each capstan bearing assy. Do not use solvents where lube belongs. Always clean such surfaces with lube.

11. Check the oil capturing felt pads, on the inside of each capstan flywheel, to ensure that it is securely attached. If not, attach with contact cement, making sure that the pads are centered.

12. Clean the old lube off of the capstans.

13. Apply 2-3 drops of sewing machine oil to each bushing of each capstan bearing assy (front and rear). Then, install a nylon washer, thrust spring washer (tines toward the flywheel), and a nylon washer on each capstan, and slide the capstans into place.

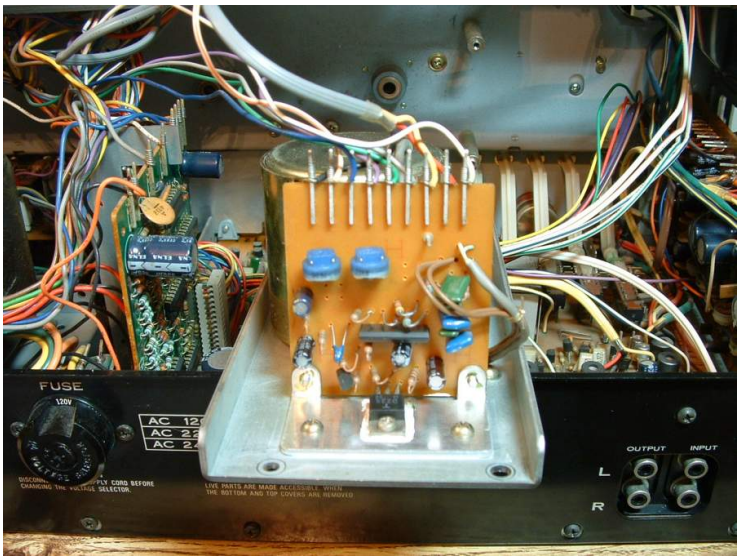
14. Install the rubber oil thrower washer back on the front of each capstan shaft, and clean the lube off of the front of the shaft (tape contact area) with isopropyl alcohol.

15. Note the position of the capstan motor drive pulley on its shaft, then remove it (loosening the setscrew), remove the setscrew, polish the pulley with brass polish, and reinstall the setscrew.

16. Lube the front bushing of the capstan motor with Teflon lube (Tri-Flow, etc.), and reinstall the motor drive pulley and secure it. Then clean off the old lube from the surface of the motor plate. Next picture shows the inside surface of the motor drive plate:

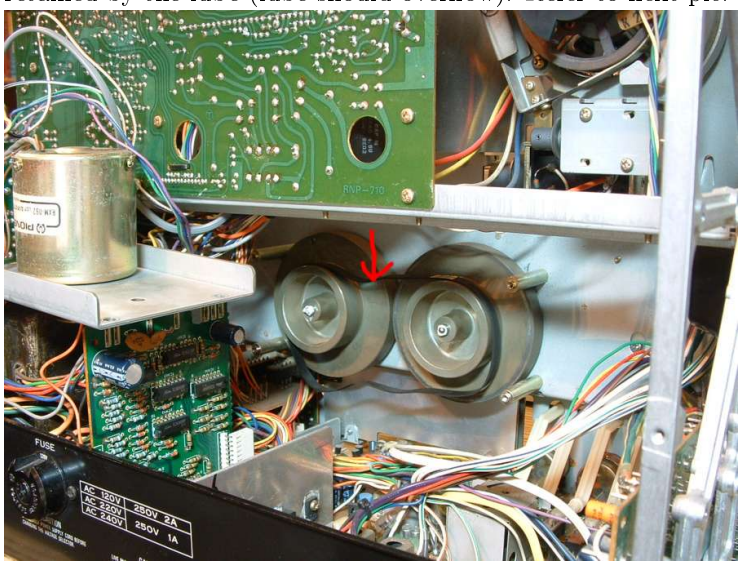
7.2 Recap Capstan Motor Drive Board

While the motor plate is removed, if you are going to recap the unit, now is the time to recap the capstan motor drive board. Replace all the 'lytic caps, refresh all the circuit board solder joints, and clean off all the old flux (isopropyl alcohol). Also, put fresh heatsink compound under the heatsink'd motor driver. *Make sure that the heatsink compound is not the kind used for computers. Computer type is conductive.* You need the kind that is non-conductive (Dow Corning 340, GC Electronics Z9, etc.).



7.3 Capstan drive work (cont'd)

1. Fill the bearing ball cups in the rear of each capstan shaft with white lithium grease, then push a nylon thrust bearing ball into each cup, to be retained by the lube (lube should overflow). Refer to next pic:



2. Install a new capstan drive belt (http://www.vintage-electronics.net/pioneer-rt-909-belt-kit.aspx). It simply goes around the capstans as seen in picture above.

3. Install the motor plate, with the motor pulley coming down on the top

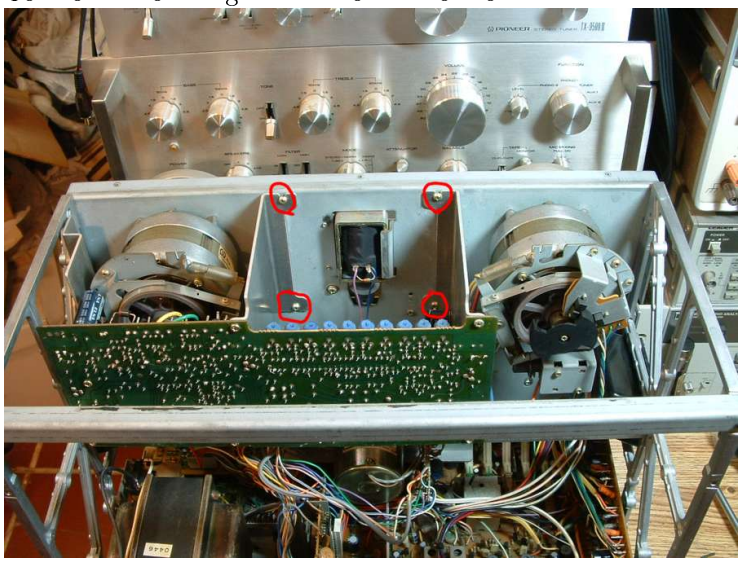
of the belt, as shown in picture above. Secure the motor plate with its 4 screws.

8 Reel brake work

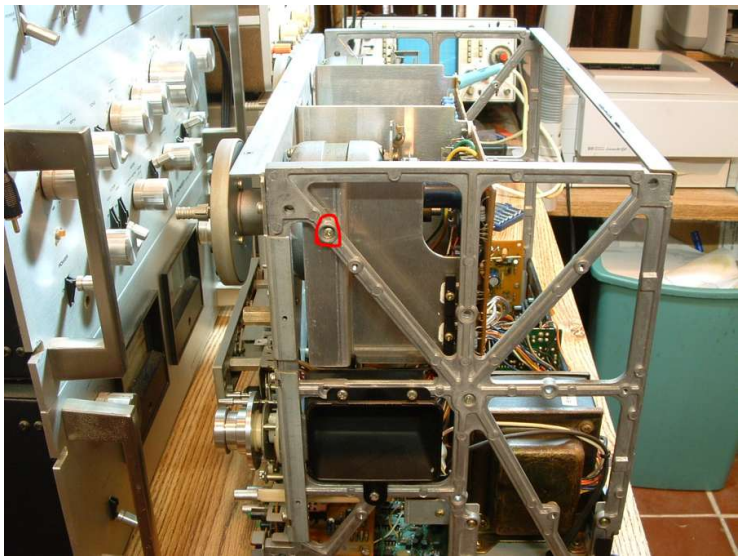
While the brakes may work fairly well on these old units, the felt brake pads can be impregnated with lube and/or fine dust, and the brake pad adhesive can be quite weak. In order to ensure longevity after all this work, I strongly recommend replacing the brake pads.

8.1 Disassembly

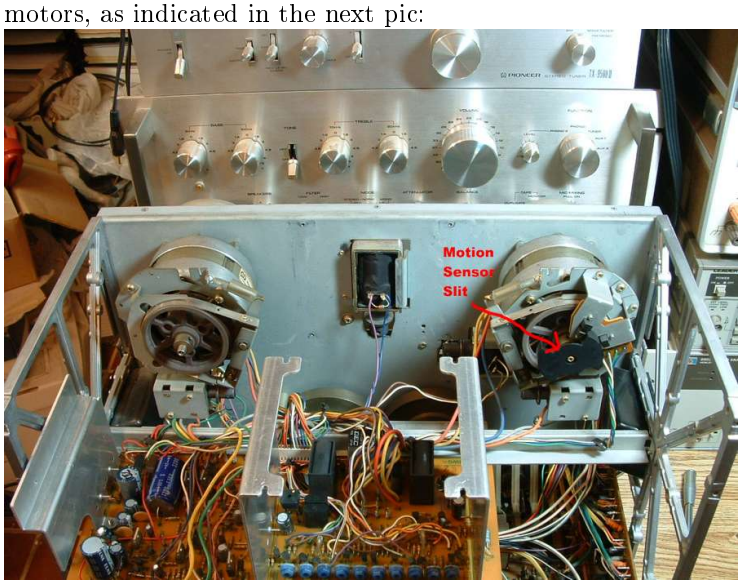
1. Remove the 4 screws (indicated in the following picture) securing the Control B mounting bracket to the front of the unit:



2. Remove the single screw (next pic) securing the Control B mounting bracket to the side of the unit:



3. Remove the 2 screws (one at each end, on the back side) securing the top frame bracket, then rotate the Control B assy down, away from the reel motors, as indicated in the next pic:



8.2 Replacing pads

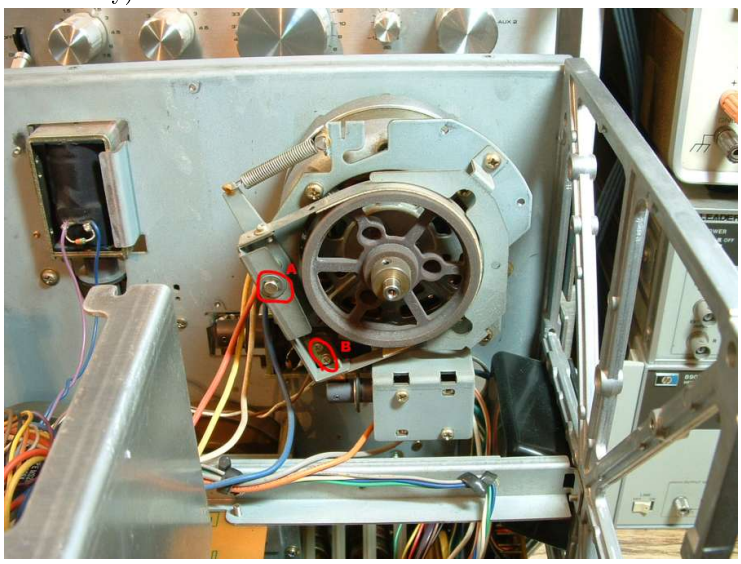
I will show the process of replacing the more complicated of the 2 brake pads. The other one will be pretty much the same thing...

1. Remove the single screw securing the motion sensor slit (indicated in figure), and remove the motion sensor slit. Then, remove the 2 screws re-

taining the motion sensor, and hang the sensor by its wire bundle (as in figure above regarding control board assy down).

2. Disconnect the brake spring from the motor assy.

3. Remove the c-clip and plastic washers ('A' in the next pic) from brake shaft. Be sure to capture both nylon washers (one one each side of the brake assy):



4. Remove 2 screws ('B' in pic 4) retaining the solenoid link to the brake, the slide the brake (& link) from the motor.

5. Mark the position of the brake drum on the motor shaft, then, loosen the setscrews retaining the brake drum to the motor shaft and remove the brake drum.

6. From the side of the unit, loosen the setscrews retaining the reel table to the front motor shaft and remove the reel table from the motor shaft.

7. Put 1-2 drops of Teflon lube (Tri-Flow, etc.) on each reel motor bushing (front and rear).

8. Reinstall the reel table, then, clean the brake drum braking surface with isopropyl alcohol and reinstall the brake drum.

9. Remove the brake band from its assy (2 screws). Carefully remove the old brake pad and its adhesive from the brake band. *Be extremely careful in this process, not to bend or kink the brake band, or you will RUIN it. Please re-read what I just wrote. It is IMPERATIVE that you heed it!*

10. Cut new pad to length with scissors & attach the new pad even with 1 side of the band. Then use a razor blade and trim the other side even with the band.

11. Reinstall the brake band, ensuring that it is square with its assy.

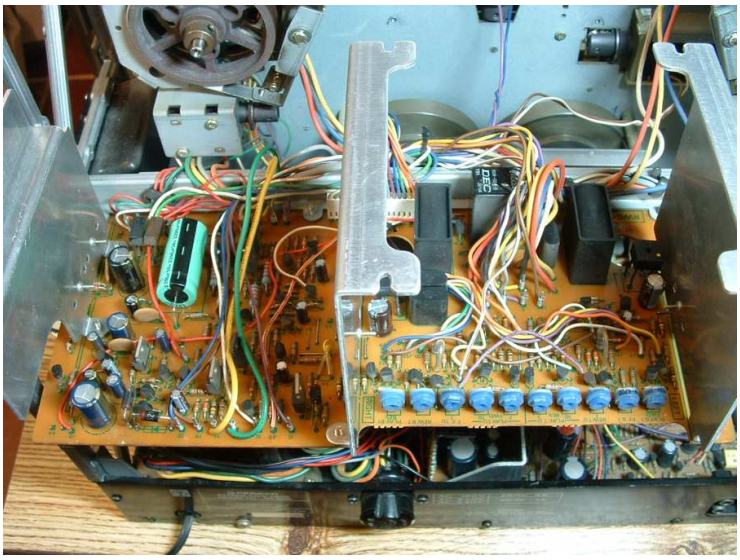
12. Lube the brake shaft with white lithium grease, install a nylon washer, then the brake assy (with its solenoid link), followed by another nylon washer and the c-clip. Then secure the solenoid link (2 screws).

13. Re-position the brake drum to center on the brake band.

14. Reinstall the motion sensor and the sensor slit.

8.3 Recapping the Control B Assy

While the Control B assy is rotated down for access, if you are going to recap the unit, now is the time to recap the Control B board. Replace all the 'lytic caps, refresh all the circuit board solder joints, and clean off all the old flux (isopropyl alcohol). Also, put fresh heatsink compound under the heatsunk drivers.

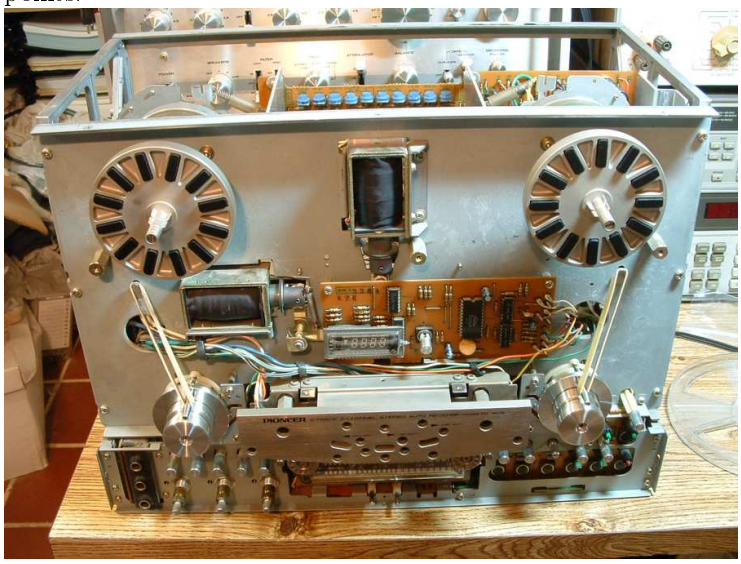


8.4 Torque Adjustments

The brake and motor torque adjustments are adequately covered in the service manual. However, here are a few considerations:

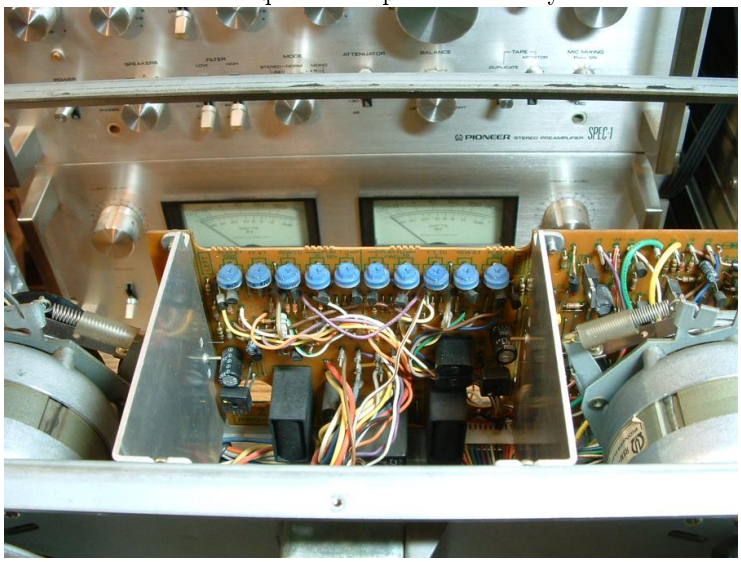
- Use a 7" reel with a hub diameter of 60mm, and a push-pull tension meter with a 0g - 500g range. Tie a string to the tension meter and wrap it in the direction of reel rotation opposite the torque being measured.

- Following pic shows how to simulate tape presence, so that the unit will attempt to drive tape. The frame front panel has tabs, intended to tie rubber bands to pull the tension roller guide pins off of their shut-off points:



- Brake torques are adjusted via brake spring tension.

- The next pic shows the pots on the Control B board, for adjusting the various reel motor torques. The pots are clearly labeled on the board:

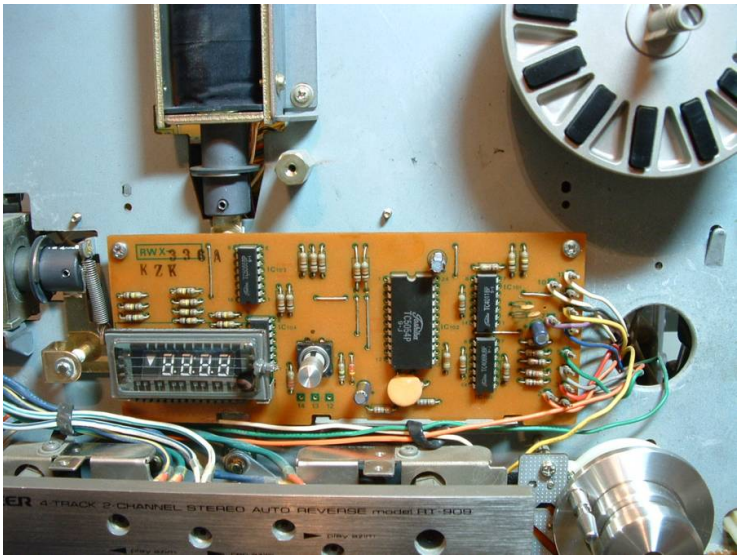


- Brake torques should only be measured after the brake has been electrically lifted then freshly released (preferably, several times).

[ADD ROBA]

9 Counter Board Recap

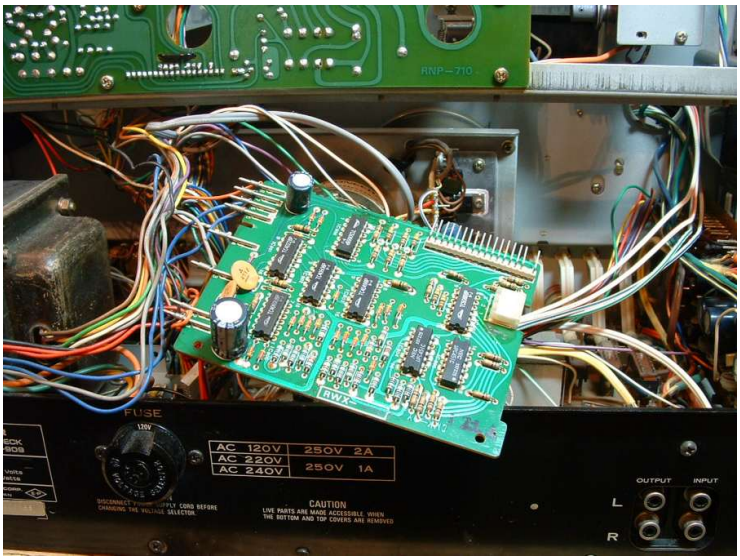
The Counter board is accessed for recapping, by removing the 2 screws securing it to the front panel, and lifting it out of its retainer. Replace all the 'lytic caps, refresh all the circuit board solder joints, and clean off all the old flux (isopropyl alcohol).



10 VU Drive Board Recap

The VU Drive board is accessed for recapping as follows:

1. Remove the single screw holding the drive board to the bottom of the frame.
2. Disconnect the connector to the VU Meter board.
3. Pull up on the Drive board, releasing it from the 3-pin connector on the Mother board.
4. Replace all the 'lytic caps, refresh all the circuit board solder joints, and clean off all the old flux (isopropyl alcohol).



Note: Leave the Drive board uninstalled while recapping the Mother board (next).

11 Motherboard

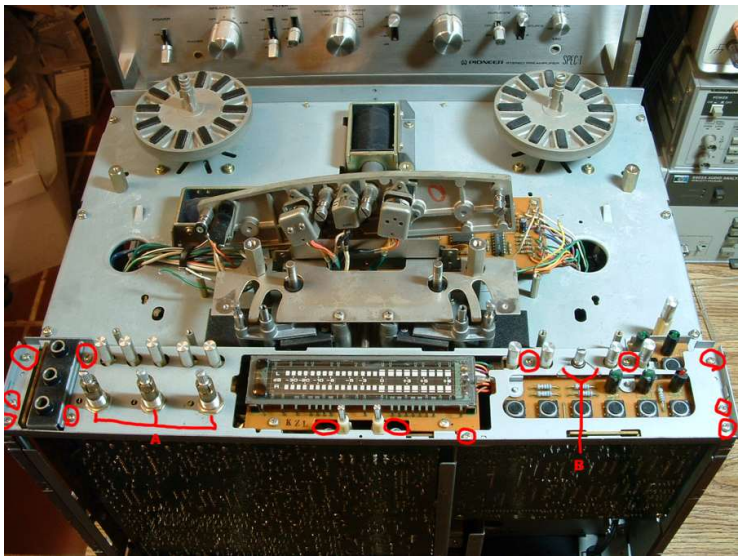
Now it gets really hairy/scary for a bit...

11.1 Motherboard Access

The Mother board is accessed for recapping as follows:

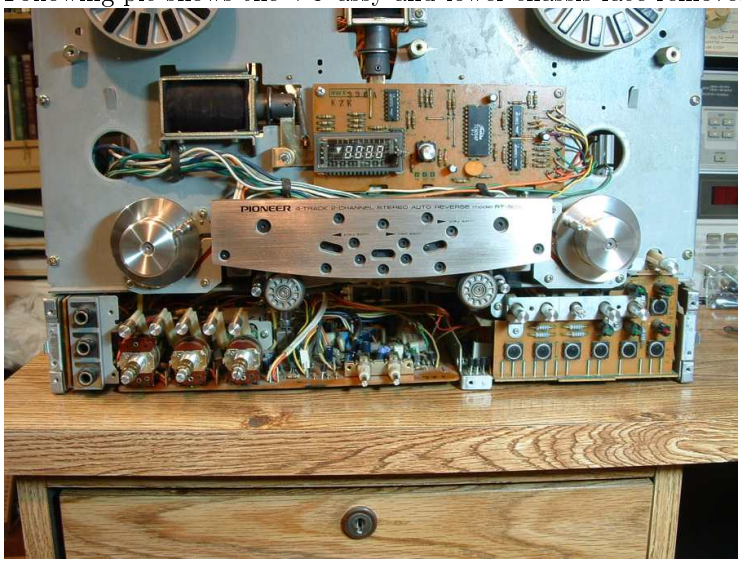
1. Remove the 2 screws securing the VU Meter & remove the VU assy (cable was connected to the Drive board).

2. Remove the grounding spring from the pitch pot ('B' in pic):

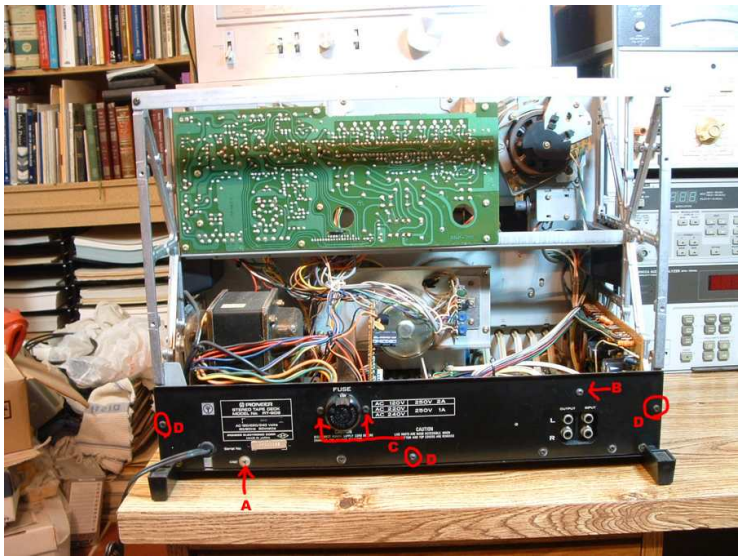


3. Remove the panel nut and washer from each of the 3 level pots ('A' in pic).

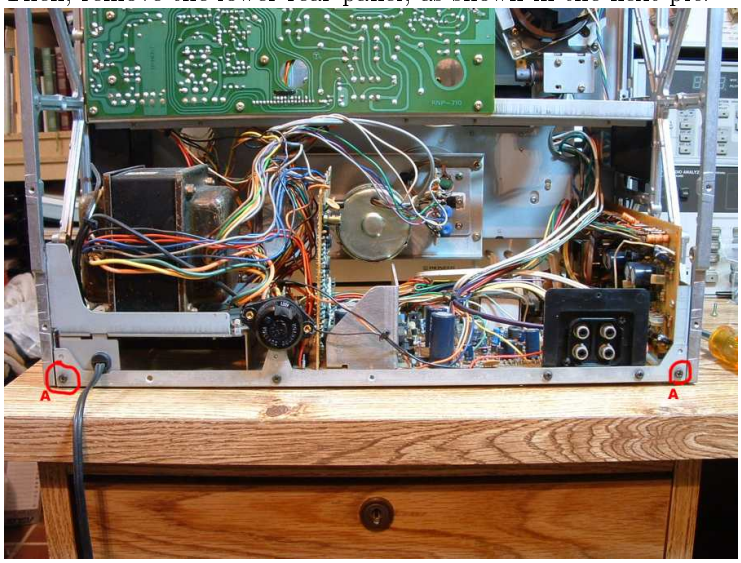
4. Remove the 13 screws securing the lower chassis face (indicated in pic). Following pic shows the VU assy and lower chassis face removed:



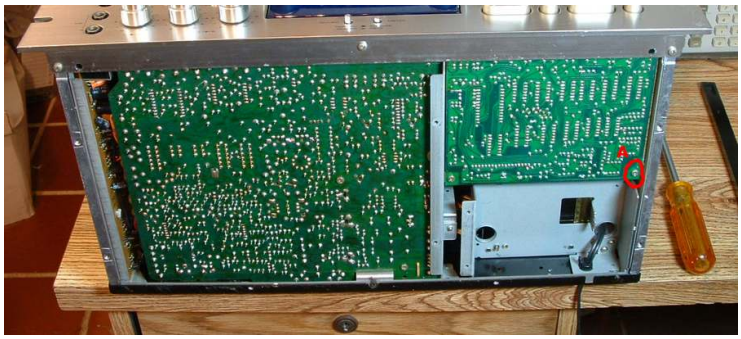
5. Remove the ground screw ('A' in pic above), the screw ('B' in pic above) retaining the signal panel to the rear panel, the 2 screws ('C' in pic below) securing the voltage selector to the rear panel, and the 3 screws ('D' in pic below) retaining the lower rear panel:



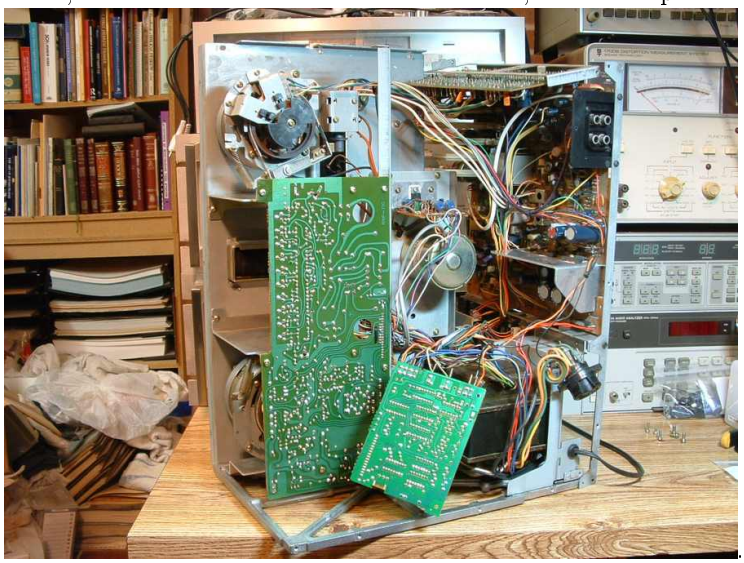
6. Then, remove the lower rear panel, as shown in the next pic:



7. Remove the 2 screws ('A' in pic above) to free the chassis to rotate open.
8. Remove the screw ('A' in pic below) securing the corner of the Control A board to the bottom right chassis side:



9. Rotate the unit onto its right side.
10. Remove the 3 screws securing the left chassis side frame to the upper front chassis face.
11. Remove the screw securing the pre-amp board mounting frame to the left chassis side frame.
12. If the top rear frame brace is installed, remove the 2 screws retaining it to the frame and remove it.
13. Remove the screw securing the left chassis frame side to the chassis center brace, and remove the left chassis frame side, as seen in pic coming next:



11.2 Motherboard Work

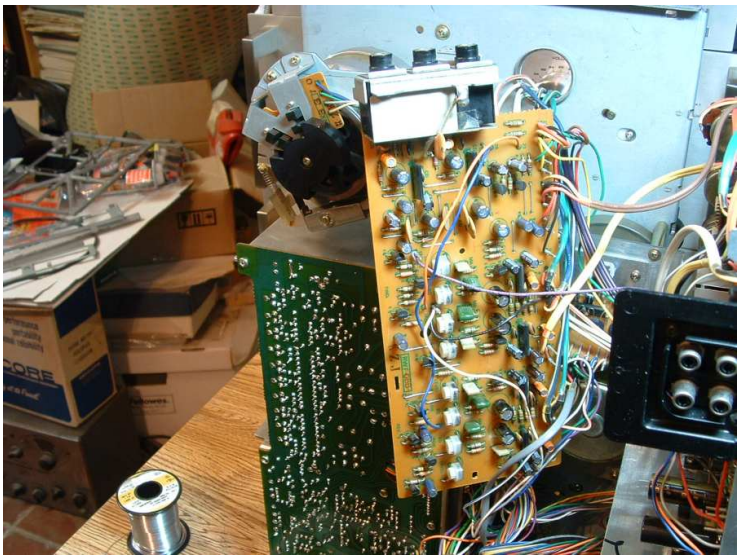
Now that you can access both sides of the Mother board, perform the following operations:

- Replace all the 'lytic caps
- Refresh all the circuit board solder joints (except those in thermal contact with any Styrol caps)
- Clean off all the old flux (isopropyl alcohol).
- Replace the old heatsink compound under all heatsink'd drivers.
- DeOxit all pots and switches on the mother board. Note: You will have to remove the shield from the 'REC Mode' switches before you can DeOxit them, remember to put the shield back on when done.
- DeOxit the contacts of the connector to the Control A board, then treat them with Pro-Gold.

12 Pre-Amp Board work

While you have the Mother board accessible, the pre-amp board is also accessible. Remove the 2 screws securing the pre-amp mounting bracket, and maneuver the bracket free (twist latching tab), then perform the following operations on it:

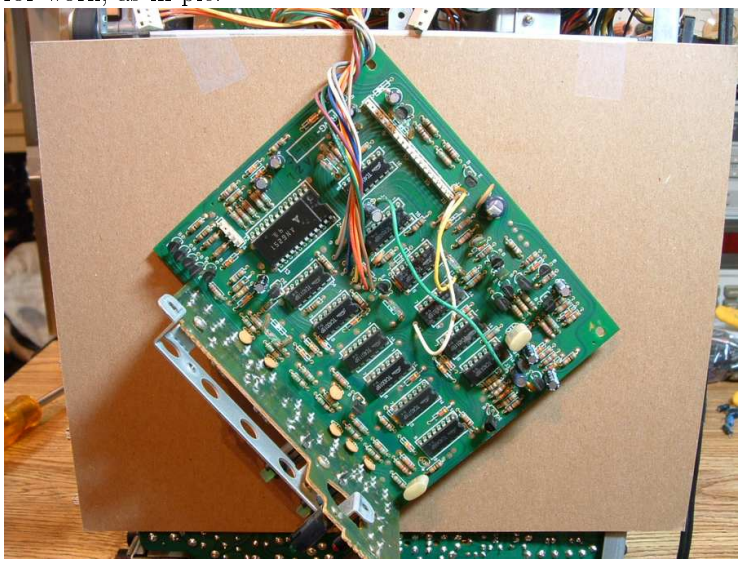
- Replace all the 'lytic caps. Note that there are a few special low-leakage 'lytics (orange ones, replaceable by Xicon LLRL series).
- Refresh all the circuit board solder joints (except those in thermal contact with any styrol caps)
- Clean off all the old flux (isopropyl alcohol).



13 Control-A Board

13.1 Access

1. Reassemble the left side, up to but not including the installation of the lower chassis faces (front and rear).
2. Rotate the unit onto its left side.
3. Remove the 2 screws (bottom) securing the Control A assy to the frame.
4. Remove the 2 screws securing the switch assy and switch array to the Control A riser.
5. Disconnect the 2 connectors from the Control A assy. DeOxit the contacts of each connector, then treat with Pro-Gold.
6. Protect the solder side of the Mother board, and hang the Control A assy for work, as in pic:



13.2 Work

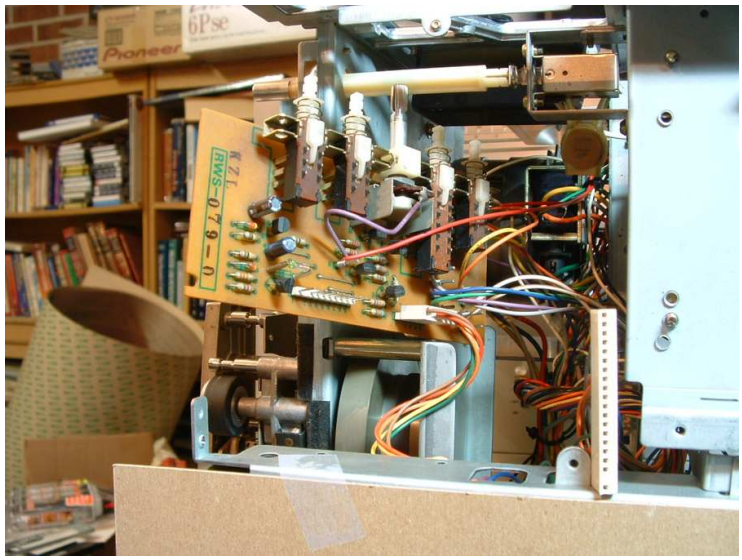
Now that the Control A is accessible, perform the following operations on it:

- Replace all the 'lytic caps. Note that there are a few special low-leakage 'lytics (orange ones, replaceable by Xicon LLRL series).
- Refresh all the circuit board solder joints (except those in thermal contact with any Styrol caps)
- Clean off all the old flux (isopropyl alcohol).

14 Switch Assy Work

While the Control A Assy is accessible, the Switch assy is also accessible. Perform the following operations on it:

- Replace all the 'lytic caps. Note that there are a few special low-leakage 'lytics (orange ones, replaceable by Xicon LLRL series).
- Refresh all the circuit board solder joints (except those in thermal contact with any styrol caps).
- DeOxit the slide switches.
- Clean off all the old flux (isopropyl alcohol).
- DeOxit the contacts of both connectors, and treat them with Pro-Gold.



Part III
Alignment/Calibration/Detailing

15 REC/PLAY Alignment/Calibration

Reassemble the unit, up to but not including installation of the cosmetic parts, faceplate, knobs and bonnet.

The REC/PLAY alignment/calibration of the unit is covered quite adequately in the service manual (head alignment, bias, EQ, levels, etc.). Here are a few considerations for this task:

- While working with the powered unit, be sure to wear adequate eye protection. 'lytic caps, installed backwards or over-voltage'd, tend to explode or go off like bottle rockets.
- While working with the powered unit, be sure to remove all conductive items from your hands and arms. There are some dangerous voltages in there.
- Before loading the very expensive calibration/alignment tape, run a few expendable tapes through, to make sure that the transport is assembled and operating correctly. Calibration tapes are over $100 each, so you really don't want to trash one.
- When it is time to put the calibration tape on, make sure you first thoroughly clean and demagnetize the transport. A magnetized transport will damage your calibration tape. I highly recommend a big Han-D-Mag demagnetizer (http://www.usrecordingmedia.com/handmagdebyr.html).
- I know that folks fawn over the old Maxell tapes, but there are new tapes being manufactured today, which can be purchased at good prices. I highly recommend RMGI-Emtec LPR35 (http://www.usrecordingmedia.com/1oprereta1.html). It is a +6db tape with most excellent results. Although it is a +6db tape, I do not recommend trying to record to the full +6db, as you are likely to saturate the heads rather than the tape. I would recommend recording to +4db, but not to mis-calibrate the VU meters to read 0db at +4db, as some do. Calibrate the meters to an accurate 0db level, but record to +4db on the meters.
- I highly recommend calibrating the unit to the tape you will actually record on. That way you have optimum response, period. That is also another good reason to use modern tape. With old tape, you never know what condition the tape is going to be in, and it is very hard to optimize the machine to allow for the wide variation you will get with old tapes.
- For a calibration tape, I highly recommend the MRL 21T204 (http://www.usrecordingmedia.com/caltap.l). It has all the tones you need for playback EQ adjustment, playback level adjustment, speed adjustment, and playback frequency response testing.
- The input signal is not listed in the service manual for the 'Level Meters 0db Adjustment'. It should be 1kHz at -10db (316mV). The input level is then adjusted for the correct internal voltage level, and the meters are then adjusted.

The following lists a few web sites for good info on R2R calibration/alignment:

- http://www.soundonsound.com/sos/1997_articles/may97/tapemaintenance.html
- http://home.flash.net/~mrltapes/mcknight_biasing.pdf
- http://www.usrecordingmedia.com/whcataareall.html

16 Cosmetic detailing

Before putting on the knobs and panels, be sure to clean them up and polish them.

Do not use harsh chemicals on the brushed aluminum. Limit your chemicals to a soft toothbrush and dish soap (not dishwasher soap).

For polishing, I suggest a good quality automotive wax. I use Meguiar's 'Cleaner Wax'.

Good luck on your own machine. Be careful. The results can make you cry (one way or the other)...

17 Known component equivalences

17.1 Diodes

- W03B, W03C: 1N4004 400 V, 1 A

17.2 Transistors

- 2SB682: 512-KSA94OTU
- 2SC1740: 512-KSD1616AGBU

17.2.1 RWG-105 board

- TIP42CTU