Fun with a Revox A-77: not for the squeamish...  Gerry O’Hara

Introduction

Around when I was 12 or 13 in the UK, my parents bought me a new ‘Ultra’ reel to reel tape recorder (manufactured by Thorn), photo, right). It was a simple mono, single speed (3.75ips) affair that took 5” spools. It’s electronics were ‘old school’ tubes (ECC83 and ECL86 I think), complete with a (bar) ‘magic eye’ (EM87). Nevertheless, it was magical to me – I was able to record my favourite shows off the radio, including Alan Freeman’s ‘Pick of the Pops’ radio show on a Sunday evenings. I used that machine every day. Soon after, my dad, an electrical/electronics engineer, constructed a Mullard 3-3 tube amplifier and matching pre-amp and made a large loudspeaker unit. Next a turntable – a Garrard SP25. Now I could compile ‘mix tapes’ from the radio and records. After that was a second amplifier and speaker to give me stereo from the turntable and the Ultra tape recorder was eventually superseded by a second-hand solid state (but stereo) Truvox. Unfortunately, the heads on the Truvox were worn and the tape occasionally jumped out of the wear path on the heads and the sound went muffled... Then I went to University and the stereo setup went into storage – never to see the light of day again. I think it eventually got dumped when my dad cleaned out his shed in the late-1990’s. I have no idea where the Ultra tape recorder went. Oh well... I have had a few cassette tape decks in the meantime, but gave up tapes altogether as my CD collection grew (and grew) in the 1990’s, played through a home brew (mid-1980’s) solid state amplifier and speakers that I still have to this day.

That Ultra tape recorder and the audio setup that went with it sparked an interest in radio and electronics in me that led to gaining an amateur radio licence in my teens and a part-time job in a radio/TV/audio repair and sales shop through to finishing at university. My career took off in other directions and eventually my electronics/radio/audio hobby went on the back-burner until around 10 years ago when I decided to restore a 1920’s radio – that got me interested in things electronic again, and after a few years of restoring vintage radios and re-licensing as a radio ham (I now live in Canada), I started thinking about audio again. Back when I had the Truvox tape recorder and the home-brew Mullard amps, I would look at the audio gear in the shop where I worked, as well as in the magazines and trade rags – I was really impressed by the audio
products of QUAD – the shop where I worked even had one or two second-hand QUAD items for sale from time to time, but the prices were in another world to what I could afford.

Fast forward to 2008 and I was visiting an amateur radio friend when we got chatting about audio amps, and guess what, he had a QUAD 33 pre-amp and 405 power amp that he offered to sell to me – a few minutes later I was the proud owner of my first QUAD audio kit. After that followed a QUAD FM3 tuner, two QUAD II power amps, QCII and QC22 pre-amps and a 303 power amp (photo, left) – but that’s all another story!

The point of all this background is to say that by early-2014 I had assembled all the amplifier/tuner components of my circa-1960’s/1970 top-of-the-line stereo system. Also, for some years prior I had been a volunteer at the SPARC radio museum in Coquitlam, BC (Society for the Preservation of Antique Radios in Canada). The SPARC museum has a (working) broadcast studio section in the display, complete with shelves of tapes that have been donated over the years. I had occasional thumbed through these and thought it would be good to have these transposed to CD or MP3 formats. Just before then, and having purchased a (thrift store) AKAI turntable and Ortofon cartridge, I had a concerted effort to do the same for my vinyl collection and had bought a neat gadget and some software to allow this – an ART ‘USB Phono-Plus’ A/D converter/pre-amp unit (http://artproaudio.com/discontinued_products/discontinued_products/product/usb_phono_plus_v2/) and ‘Spin it Again’ software (http://www.acoustica.com/spinitagain/). I spent weeks doing this and then started thinking about the SPARC museum tapes again – it became obvious that I needed a tape recorder again! But which one? I had always admired high-end TEACs and AKAI machines, as well as the legendary Revox decks - both well out of my price range back in the day...

The Purchase

So, I started perusing EBay and after a few weeks spotted a classic Revox A-77 for sale in the Vancouver area – two advantages here: I could see/try before I bought and no shipping costs! I forked out the cash and went to collect the deck. The seller had it set up playing a tape, but when
I tried recording, there was nothing doing – only some indication on one VU meter of anything happening but nothing recording on the tape. Tried cleaning the heads, still nothing. After some discussions, I was offered a full refund or I could have the deck at a much-reduced price. The deck, an early-MkI, was in very good cosmetic condition and appeared to function mechanically, so I decided to go for the low-price offer, sweetened by some bottles of delicious Czech beer supplied by the seller (cheers Tim!)... and that was the start of my love-hate relationship with Revox A77s...

**On Arrival**

Back in the workshop, I stripped the machine down and gave it a really good cleaning. Everything looked original – no repairs to the circuit boards etc. I noticed that the contacts on the long switch that sets the correct equalization for the different speeds were very tarnished and that the capstan motor was rumbling, along with the capstan itself being grooved. The heads looked very worn and on close inspection (photos below – left: playback head, right: record head) were found to be covered by a thick deposit of ‘varnish’, especially over the record head surface – likely the result of long periods of playing ‘sticky-shed’ syndrome tapes on it without frequent cleaning. Adding all these things up I was starting to think it may be better to buy something else as I was no tape deck expert and my main reason for having a recorder was to transpose old tapes onto modern
formats. Could I justify the level of effort and expense needed to render this deck fully-operational?

Decisions

After reading-up quite a bit on Revox machines, and the A-77 in particular, and given the state of my recent purchase, I had to decide whether to cut my losses and ditch the deck (sell-on to someone) or start investing in its restoration – realizing that there would be a steep learning curve and that the exercise was not going to be cheap. Well, I am a bit of a sucker for ‘basket case’ vintage radio restoration (and detest giving-up on anything), and I really did want a fully-working Revox in my collection – it had been sitting amongst my vintage QUAD gear and just looked ‘right’, so... I decided to ‘bite the bullet’ and start investing – both time and money.

Parts Acquisition – Part 1, and Information Gathering

Given the state of the heads I decided to find some replacements. EBay came to the rescue with a complete headblock (photo, below), albeit from a later model A-77, for a reasonable price and with much less wear. The seller was in Montreal, so shipping costs were reasonable. I had read that may of the tantalum and electrolytic capacitors (especially those manufactured by ‘Fraco’) in these decks were suspect, along with the motor run capacitors and a number of X-class (paper) safety capacitors used in the tape transport.
circuit (manufactured by Rifa in Sweden, named ‘Miniprint’) – the gold-coloured capacitors in the photo, right, the former often developing physical leaks (mine had not) and the latter tending to split and emit smoke and a stink... so I decided it would be prudent to ‘re-cap’ the deck. Another problem often noted with the A-77 deck in the various forums (and evident from inspection of my own) is that the various trimmer potentiometers on the circuit boards tend to fall apart with age and/or become very tricky to adjust. I decided these should be replaced also.

Manuals and schematics for the A77 (and other Revox decks) can be downloaded free of charge from the Studer site (ftp://ftp.studer.ch/Public/Products/Revox/), as well as HiFiEngine (http://www.hifiengine.com/manual_library/revox/b77.shtml) – just be careful of referencing the correct version of the deck as there are changes between the versions (some cosmetic, some subtle electrical/mechanical, some not-so-subtle), even though the basic machine design and layout stay very similar. There are also variations in number of tracks and speed combinations and also input/output connectors (‘Pro’ versions fitted with ‘XLR’ connectors).

Although I could have sourced the parts locally and/or from mail order, I found a supplier on EBay (Nagravox – run by Peter Mony out of Australia) that provided a complete capacitor/trimmer kit of quality parts at a very reasonable price, including bespoke motor run and power supply electrolytics with the correct screw fitting bases – so, I ordered a set, noting that my deck was an early MkI (May, 1968 date marked on the reel motors, though the Serial Number is missing, so cannot be more precise). The early MkI deck has a few electronic and mechanical differences to that later models of A-77 (and later MkIs for that matter), with some capacitor and resistor values being different, and a different power supply, transformer and capstan motor/control board design. Peter’s kits cater for these variations.

**Refurbishment – Step 1 (electronic)**

The capacitor kit duly arrived, along with a very detailed and helpful set of fully-illustrated instructions via email. The supplied electrolytic capacitors are high-quality 105C parts. The kit includes electrolytic replacements for all the tantalum capacitors (bead-type tantalum capacitors currently have variable support in the electronic world, although they were considered the ‘best
thing since sliced bread’ back in the late-1960’s/1970’s. Since then they have a reputation for exploding, going leaky (low resistance), and/or changing capacitance value"). I tested the leakage and ESR values of the new parts before installing and all performed well.

The A-77 is a classic piece of modular electronic design, with each electronic function of the machine being assigned to a separate circuit board: power supply, tape transport (photo, above, after re-capping), capstan motor speed control, VU-meter, input amps, record amps, playback amps (photos above – before and after recapping), bias oscillator, record relay and (optionally) power output amps. The amplifier boards, along with the bias oscillator and record relay boards plug into a long ‘motherboard’ (referred to as the ‘switchboard’ in the Revox Service Manual) that incorporates most of the front panel controls (record, replay levels, balance, input selectors etc). This form of construction makes for a relatively easy re-cap effort as it can be done board by board and the operation of the deck checked after each board has been upgraded. The various circuit boards, when not being

1 I tested all the tantalum capacitors removed from my A-77 and only three exhibited slight leakage and capacitance values slightly lower than the marked values. The Fraco electrolytic capacitors on the other hand almost all had excessive leakage and/or out of tolerance capacitance values. The Rifa X-class (paper) capacitors were all slightly leaky, with around 2Mohm DC resistance – incidentally, I borrowed an A-77 MkIV Dolby deck from the museum while I was working on my A-77 and one of these paper capacitors ‘blew’ rather spectacularly in this machine when I was using it one morning – much to my (and my cat’s) surprise - the stink was awful...
plugged into end-connectors, are connected together and to the motors etc, with miniature ‘spade’ connectors, which makes for easy disconnection/connections during servicing.

The power supply and capstan motor control boards are attached to the power transformer and it is easier to partly remove this assembly complete to work on these boards. This and also the ‘motherboard’ are the most difficult to access – the motherboard in particular needs quite a bit of disassembly to allow it to be extracted (or partially) – sufficient to allow replacement of the electrolytics and trimmer pot located on this board (photos, left – before and after re-capping).

No real problems were encountered with the re-cap work, or with the trimmer pot replacement (Peter even supplies a spreadsheet to calculate the resistance ratios to set the new pots to the same setting as the parts being removed), except some of the pots need a little mechanical tweaking to fit into the holes on the circuit boards and I found the large electrolytic on the record relay board had to be laid on its side rather than upright as it fouled the adjacent circuit board when installed in the motherboard (Peter noted he had not heard of this problem before) – no matter, it was a simple fix. Having a Hakko desoldering tool really helped with removal of the old components as the printed circuit tracks reportedly have a tendency to part company with the board when heated with a soldering iron and manipulating components to remove them.

The long multiple contact switch (visible on the photos above and right) that serves mainly to change the equalization for the different tape speeds (3.75ips and 7.5ips on my deck) took some serious effort to clean using a fibre glass pen and Deoxit D5 and ‘neat’ Deoxit. A squirt of Deoxit
D5 was given to each of the variable pots on this board also and other switch contacts in the deck were cleaned with Deoxit and Q-tips. The relay contacts on the tape transport board were cleaned with a burnishing tool and Deoxit.

**Refurbishment – Step 2 (mechanical)**

On using the deck after the electronic refurbishment, the rumbling capstan motor became more and more annoying. I also noticed that there was a distinct ‘wow’ near the end of small spool tapes (even on the small spool setting), that the rewind/forward reel motors were rather noisy, the pinch wheel was rather hard, and the tape counter could not be reset reliably. What to do? I contacted Peter at Nagravox and he noted that he could supply all the parts necessary for a mechanical refurbishment. Soon another kit of parts were winging their way from Australia:

- Tape Transport kit (tape guide bearings and shims);
- Pinch wheel;
- Reel motors ball bearing kit;
- Capstan motor ball bearing, anti rotation clip and Belleville washers;
- Lubrication kit (recommended oils and applicators).

Again, Peter supplies some excellent literature to go along with the above. The reel motors (photo, below, right) proved a little difficult to disassemble (stubborn c-clips etc), but once apart, the new bearings installed fairly easily (two per motor) and the kit included new c-clips etc. The capstan motor also proved remarkably easy to refurbish and the tape transport and pinch wheel were a breeze. The difference that the new reel motor bearings made was remarkable – silent operation and soooo fast! The new bearings in the tape transport guides helped when playing sticky tapes. The big disappointment was the capstan motor – it remained ‘rumbley’. Worse, there was now a loud whining present that changed with the motor speed (eventually traced to the tacho sensor).

After discussing these issues with Peter, he suggested that it may be the sintered bronze (upper) bearing in the motor, and that given this and the state of the capstan (photo, left), it may be a better bet to buy
another motor. Back to EBay and I purchased a replacement capstan motor (same type, for the early MkI). This motor proved to have much the same issued as the original one, however, the capstan was in much better shape (no ridges and grooves), so I focussed on getting this one sorted out. Fitting the new bearing and Belleville washers did not seem to help any and I became an expert in disassembling/re-assembling this motor, trying various combinations of washers and bearings, including a Japanese-manufactured (NSK Z809) one sourced by a friend at the SPARC museum. After much frustration (lasting several weeks!), and much further assistance from Peter at Nagravox, including him sending another capstan motor bearing and Belleville washers (different types - photos at top of next page), I found that placing the Belleville washers on the opposite side of the ball bearing (moves the sintered bronze bearing/capstan shaft mating surfaces about 2mm down), installing the NSK bearing, and adding a thicker rubber washer beneath the tacho sensor, as well as spacing it further from the motor rotor (another of Peter’s suggestions) quietened the motor considerably – both the rumbling and
the whining were gone – the motor noise now being more like what I would expect (maybe slightly noisier than I would really like, but acceptable). I suspect the distance the tacho sensor is from the rotor is critical and that this may have been the source of not only the whine (as the manual notes it can be), but also the ‘rumble’, which may have been an artefact of the servo control being overloaded with pulses from the sensor and therefore producing poor regulation of the capstan motor (though the tape speed was held steady as it should be, even with the rumble). Having got it silenced, I am loath to investigate further (for now at least!).

The ‘wow’ increasing towards the end of a reel was traced back to the brakes needing adjustment and a weak brake solenoid (both this and the pinch wheel solenoid were replaced with ones from a ‘parts’ MkIV deck at the SPARC museum, having read that the dull chrome-plated armatures of the earlier machines tended to lose their magnetism). Tweaking the brake band levers then synchronized the two brakes and allowed the reels to run freely when the brakes were not actuated.

Head Alignment

It had been decades since I aligned a tape deck – way back in my youth when I worked at a radio-TV service shop. A test tape was located at the SPARC Museum (not a very good one, just three tones recorded twice each on a tape that runs for 10 mins or so at 7.5ips). The recording level is not stated on the tape box. Anyway, this still provided a useful way to set up the record and playback head azimuth. The head block acquired from EBay had just been installed as it arrived (after a clean-up and demagnetization). The tape appeared to lay central to the heads and
as the height and head angle adjustment screws were sealed, I left them alone. The azimuth adjustment set-up was straightforward, playing the tape and monitoring the output from the deck on a dual trace oscilloscope. The azimuth screw was adjusted for maximum output and then for phase (this can be by using a Lissajous figure if the decks outputs are connected to X and Y scope inputs, however, I just made the adjustment visually by comparing the output from each channel on the screen).

**Electronic Alignment**

The A-77 manual provides a comprehensive set up procedure for the playback and record amps as well as the bias oscillator, VU meters and (record) equalization, plus bias traps in the record and playback amplifiers. I tried to follow these but found them a little confusing the first time, however, working through them a couple more times they made more sense and I eventually managed a reasonable set-up. Having a decent AC millivoltmeter helps (an HP400E in my case), as does a dual trace oscilloscope (have an HP1725A and a Hitachi V-212), as well as an audio generator (a Heathkit IG5218 here).

Essentially this is what I did:

- Mechanical head alignment as noted above;
- Adjust 21v supply line to exactly 21vDC;
- Using the alignment tape, playback at full volume, balance control at centre position, and observe output level on millivoltmeter. Adjust replay amp levels to obtain same output on both channels per Service Manual (2v RMS). Check this at all three frequencies on the alignment tape;
- Load a ‘scratch’ tape onto the deck and setup for record on Aux inputs. Feed 4mV at 1kHz into Aux inputs, start recording. With monitor set at ‘input’ fine tune input level for 200mV output (again with volume control at max, and record levels at max);
- Switch to monitor off tape (NAB) and adjust record amp gain to match the 200mV output level observed on ‘input’ setting of the monitor control;
- Change to 12kHz input frequency and adjust the equalization (‘EQ’) for the speed setting in use until the same output level is observed as at 1kHz (these steps to be repeated for other speed);
- Set the VU meters by monitoring the waveform of the output and increasing record level until a distorted sine wave is observed, back off 6dB and set the VU meters to read 0dB (I found this to produce good results, however, I will be making these adjustments again once I have a better test tape that includes a known level setting on the tape);
- Follow the Service Manual instructions for checking bias oscillator frequency;
- Follow Service Manual instructions for record and replay bias traps;
- Set bias level for tape in use: per the Service Manual method, (and advice that can be found on many forums), ie. with a 10kHz input signal, wind the bias level up until the output level peaks and then drops back around 3dB (depends on tape type).
As noted above, I intend to re-tweak the above once I have a better alignment tape, however, the results I am now obtaining with the deck are very good. I noted a couple of odd issues during the above:

- Channel I record amp gain pot is at maximum, whereas Channel II is midway (where I think it should be) to obtain equal gain levels – this suggests that there is a fault in the Channel I record amp. Peter suggest it may be a faulty BC109 transistor in this stage (there are two) and notes that it is not uncommon for their the transistor gain (‘hfe’) to drop from around 300 to 30 for no apparent reason. Next time it is out of its box I will be doing some checks;

- I could only obtain (almost) flat response with the EQ trimpots at full-on. This again suggests that there may be a general lack of gain in the record amp stages (though this observation applied to both channels).

Closure

Well, what can I say – when I started out, I knew little about tape recorders (other than what I remembered from my youth). The A-77 has certainly turned out to be an interesting (if very frustrating at times) project, and I have learned a lot. The A-77 is designed to be worked on/serviced, much like the subjects of my other hobby, that of vintage radios (mainly tube-based from the 1920’s through 1950’s). Its construction and (relative) simplicity of design (compared with many other manufacturers of quality decks of the same or later period) makes for this being a good tape project to cut my teeth on. Also, the popularity and length of the production run of the A-77 (8 years) means that there are many spares out there at not too unreasonable prices. The heads have got a bit of a bad rap in the various forums for being a ‘bit soft’ and therefore prone to wear, though I suspect these decks were ‘hammered’ in their time as semi-pro recorders and it’s not surprising that their heads are worn after decades of use.
However, I doubt I will be using my deck to excess, so I expect the replacement heads in my deck to last quite a few years\(^2\).

So, what has this cost me?

Deck - $100 (including Czech beers and a demagnetizer, but no shipping!)

Head block - $75 (complete with 3 heads)

Capstan Motor - $40

Capacitor/trimpot kit - $85 (motor and board capacitors and trimpots)

Reel motors, capstan motor and transport bearings/Belleville washers, c-clips, anti-rotation clip, bulbs, counter belt, pinch wheel, lube oil etc. - $160

Total outlay $460 (excludes new tapes and spools, NAB hub adapter refurb kit, shipping costs, etc).

Was it worth it? – I would say yes. I now have a ‘classic’ A-77 MkI that looks, feels and sounds great and that really ‘looks the part’ with my 1960’s/1970’s HiFi kit, adding that certain caché that only a machine that sports 10.5” aluminum spools can. It has allowed me to listen to and record to MP3/CD from numerous tapes of a wide variety of material in the SPARC museum sound archives. Not only that, it’s been (is) a great educational item... Brilliant!

\(^2\) I may even have a go at re-lapping the old heads (I found a Nortronics head re-lapping kit at the SPARC Museum) – nothing really to lose...