Improving a Revox A77

Part One **By Angus McKenzie**

IT is well known that Revox model *A77* recorders can make recordings of a very high standard although certain facilities are lacking on the machines. facilities which are normally required in professional use. This article describes how a number of modifications can be incorporated, making the machine suitable for use as a high standard, professional mobile recorder.

The Revox is available with or without loudspeaker amplifiers and, when supplied with amplifiers, can also include built in loudspeakers, if required, in a version known as the suitcase model. The machine is available with two speeds, either 9.5/19 cm/s or 19/38 cm/s. The high speed version is often termed the professional version. The low speed model is usually supplied with NAB equalisation whereas the high speed model is normally supplied as a DIN version, although NAB can be supplied to special order.

Most studios use a nominal peak line level of six on a ppm equivalent to +8 dBm. Alternatively studios using vu meters will frequently be driving levels of up to +14 dBm under normal conditions, and transient peaks of up to +16 dBm are occasionally encountered. When not modified the Revox input circuit clips if the input exceeds approximately +11 dBm, and the output circuit clips at approximately 13 dBm into open circuit and +8 dBm when loaded with 600 ohms. It will be seen therefore that an unmodified Revox *77* will record severe clipping distortion on its input amplifier when used across the output of many professional control desks or systems. Many engineers who have not had the time to look into the reasons for this have blamed the electronics of the record amplifier. Similarly very high output tapes when played back on the Revox may well distort at the output sockets on the machine due to the monitor line out amplifier being overdriven. Many Revox owners have commented to me that the hiss level deteriorates on playback, or indeed when monitoring line input if the replay gain control is used at about 6 dB down from its flat out position. Also some users have noticed that the monitoring circuits load down the input of the record amplifiers by 1 dB when in the line in monitoring position, this position therefore dropping the record level by the same amount. It is worth pointing out here that if the replay volume control is set flat out and the mode switch set such that tracks one and two are combined for mono, should the a/b switching be left inadvertently in the 'line-in' position, the recording made will also be mono, even if all the record amplifier controls are set to stereo.

The Revox can in some cases also produce an earth loop, particularly when both the auxiliary input and output phono sockets connect with external equipment. In some cases readers have also had radio frequency interference problems which can become quite noticeable under certain conditions, particularly on replay. In addition to radio breakthrough, noise from lighting or power circuits may be noticed.

In order to appreciate the reasons for the different modifications proposed it is useful to regard the different circuits in the Revox as a series of operational amplifiers and these will now be described.

The input pre-amplifier in the record section has different gains controlled by changing the amount of feedback, the gain change being achieved by the input selector. The low impedance microphone input has the highest gain and hence the least amount of feedback, whereas the auxiliary input has the least gain—in fact almost unity gain—achieved by nearly 100 per cent feedback.

The input preamplifier has a fixed gain in any one position and its output feeds the record volume control. The outputs from the two channels can be resistively mixed, the output from this point feeding both the input to the record amplifier proper and the a/b monitoring switch. The mixing resistors form a 6 dB pad when the machine is used for stereo and the source impedance of the a/b monitoring amplifier is largely controlled by the value of the replay volume control, which is 25 kΩ. When the a/b switch is in the 'line in' position this affects the output of the 6 dB pad, which follows the record volume control, by 1 dB. This affects the level read by the vu meter and thus the level recorded on to tape.

Record amplifier

The record amplifier contains the recording equalisation circuits, the equalisers simply shifting the point above which a 6 dB per octave boost curve is applied to give the correct overall response. The output of this record amplifier drives the vu meter circuit with both its own preset and the record level preset pot enabling the correct a/b level balance to be achieved. The available amount of record equalisation can be altered if necessary by adjusting the value of the capacitors connected to the sliders of the record equalisation presets.

The record head driver circuit includes two transistors; the head is driven from the junction of the emitter of one with the collector of the other. The emitter circuit of the second transistor includes the extra components giving the treble end of the NAB response curve, and consists of an RC time constant in parallel with the emitter load section, this circuit giving approximately a 3 dB shelf treble lift. In series with this circuit down to ground is a 38 kHz filter to stop any interference which might be produced by harmonics from some stereo tuners beating with the bias supply.

The replay amplifiers have the replay equalisation applied back to the first emitters and are followed both by the replay bias traps and by the replay preset gain controls, the output of which feeds the a/b monitor switch. The a/b monitor amplifier follows the replay gain control and has an unnecessarily high input impedance. The balance control operates by reducing feedback in one channel, thus increasing its gain, at the same time as increasing feedback in the other channel, reducing the latter's gain. The line output is taken from the final emitter of this amplifier which also drives loudspeaker amplifiers if present.

Since the record preamplifier when switched to the auxiliary position has normal unity gain its input clipping point is virtually the same as its output clipping point and this is determined both by the type of circuitry employed and the rather low ht voltage. Since the gain of the amplifier cannot itself be reduced it becomes necessary to apply a resistive pad on the auxiliary input to decrease the level applied to the preamplifier. An 8 dB pad giving an input impedance of approximately 50 kΩ can be achieved by using a series 27 kΩ resistor followed by a 22 kΩ resistor to earth. These are best mounted immediately behind the auxiliary input phono sockets. This modification will give an input clipping level of about +19 dBm which should be sufficient for any requirement.

To obviate the bridging effect of the replay amplifier on the record circuits the entire resistive mixing pad circuit should be removed although this will lose the facility of input mixing when half track mono recordings are being made. The source impedance then becomes approximately 1.3 kΩ, sufficiently low to avoid bridging loading.

The a/b switching on the Revox is carried out at a very low level so that if the machine has been set up normally only 9 mV are present when a level of 0 vu is being recorded or played back. Since the monitor amplifier has therefore to bring this up to a level of approximately 1.25 volts (43 dB gain) and also has a high input impedance it will be seen that when the replay volume control is 6 dB down from maximum the source impedance to the monitor amplifier is at its greatest thus causing audible hiss. The only way to reduce this is to decrease the gain of the monitor amplifier and increase the level at the a/b point. Thus the record amplifier will be driven 10 dB harder and will have a 10 dB worse clipping level. The record amplifier gain has therefore also to be reduced by 10 dB and this is best achieved by increasing the emitter resistor from 1.5 to 4.7 kΩ. So as not to alter the dc conditions seriously the first collector load should also be increased to 220 kΩ, thus stabilising the dc feedback. On some machines it may be found necessary to alter the capacitor

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in the lower speed equaliser to a considerably lower value to reduce the minimum amount of equalisation available at this speed. At the higher speed however no change need be made.

The reduction of gain in the record amplifier will also slightly reduce its contribution of hiss, and the 10 dB loss of record gain can be made up by increasing the record volume control. It is fair to point out that unless the 6 dB pads are removed this loss of gain will become significant when moving coil or ribbon microphones are used direct into the Revox for the recording of speech or quiet sounds. It is possible that an extra microphone preamplifier might then become necessary. This is desirable in any case since the Revox has only unbalanced inputs for microphones, often the cause of tricky hum and rf pick up problems.

In order to make a standard, low speed Revox record accurately to the DIN curve at 19 cm/s the RC circuit of 2.2 kΩ and 0.033 μF should be disconnected. This will be found to give a treble reduction at 9.5 cm/s which can easily be corrected by increasing the equalisation at the lower speed only. The DIN response achieved will be considerably more accurate than that produced by only reducing the equalisation at 19 cm/s for DIN response. On most machines it will not be found necessary to alter any components on the record circuit to give a bass response within specification for DIN although the best compromise between the two lower speeds can be achieved by increasing the value of the bass boost capacitor by 20 per cent (0.1 μF being changed to 0.12 μF) found in series with the equalisation pots.

The monitor amplifier gain should be reduced by short circuiting a 22 kΩ resistor between the slider of the balance pot and the first emitter of the monitor amplifier. It is also necessary to insert a hold off resistor of 2.7 kΩ in the feed to the top of the balance pot where it is driven via a capacitor from the output emitter. This prevents instability when the gain of the amplifier is reduced to near unity as the balance control increases the gain of the opposite channel.

The clipping point of the monitor amplifier is normally at approximately +13 dBm into open circuit and this prevents standard play tapes recorded at only fairly high levels from driving external equipment at as high a level as is frequently necessary. If a Dolby, for example, is required to be driven by the monitor amplifier to replay Dolbyed tapes and the gains are set up such that Dolby level gives an output from the Revox of +4 dBm into the Dolby, many tapes will be subject to clipping. Two modifications are therefore required which will improve the clipping level substantially. The dc conditions of the monitor amplifier can be controlled by altering the value of the emitter resistor of the second stage which drives the output stage. The best compromise is to reduce this from 1000 to 680Ω. In addition a 560Ω resistor is permanently in series with the output which is also effectively loaded by 9.4 kΩ produced by the resistors feeding the five pin DIN socket. The 560Ω resistor therefore gives 0.75 dB reduction in level at the output terminals and is best shorted out. The two 4.7 kΩ resistors however should be left in circuit to allow the output coupling capacitor to have a dc return enabling it to charge up. Care should be taken to avoid short circuiting the output of the Revox when this modification is done since the 560Ω is in fact present in the normal circuit to stop domestic users from overloading the output stage through misuse.

The clipping level of the monitor amplifier now becomes approximately +17 dBm in to as low as 5 kΩ and a 600Ω load will cause clipping at +12 dBm. The modification allows any but the most excessively highly recorded tapes to be played back at compatible studio levels. If necessary both the auxiliary input and output circuits can be provided with 1:1 balancing transformers, the input transformer being of nominal 10 kΩ working impedance whilst the output transformer should be of 600Ω nominal impedance. The input and output sockets will then have to be replaced by more suitable balanced sockets.

The replay preset gain control will be found to have an ample amount of gain to spare and will easily give the extra 10 dB required by the modified monitor line out amplifier. In the high speed version, as supplied direct from Switzerland by Studer, both positions of the equalisation switch at the higher speed normally have the same equalisation although on the lower speed version either NAB or IEC high frequency characteristics are available. It will be noticed on examination that this high speed version has a short circuit on the printed circuitry allowing only one replay characteristic at the higher speed. This should be replaced on the DIN version by a resistor of 1.5 kΩ which will then give a useful NAB 38 cm/s 50 μS time constant with the switch fully clockwise. A 3 dB rise at 50 Hz however may be noticeable but by adjusting the high value resistor across the replay amplifier time constant capacitor the error can be reduced to 1.5 dB at 50 Hz which will unfortunately also give a 1.5 dB reduction of bass at the same frequency on the DIN curve. With this latter modification however both bass responses will be found to be within the DIN or NAB curve specified tolerances.

The final recommended modification is first to couple a 100 pF capacitor between the bass and the emitter of the first transistor in the monitor amplifier to reduce pick up of rf interference. On my own machines I have also taken off the earth return from the output circuit to the auxiliary phono sockets and replaced these by short circuiting the capacitors coupling the phono sockets earths to the DIN socket earth. This changeover has removed almost all the earth looping problems experienced by the writer when four separate phono leads, or a combined lead with four individually screened phono leads as is supplied by Tape Recorder Spares, connect the Revox to external equipment.

The distortion was checked throughout after all the modifications had been introduced. On the three machines so far modified the distortion on monitor line in up to 1 dB below clipping point is less than 0.05 per cent total. At 1 kHz the recording amplifier distortion measured at the record preset point at a level equivalent to 10 dB above 320 pWb/mm with the machines set for EMI *815* tape was less than 0.06 per cent, although of course the tape distortion produced at this level is extremely

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high. At all normal levels the measured tape distortion is very close to the theoretical values obtained from the manufacturers published figures. It is curious that if the vu meter circuit is disconnected the distortion drops to 0.035 per cent and although a brief attempt was made to reduce the very slight distortion introduced by the metering circuit no significant improvement could be gained. It is felt that some users might prefer to drive the vu metering circuit from the monitor line out which has a considerably lower source impedance. This might well prove to be more useful allowing output levels to be monitored. I do not use the Revox vu meters on programme, however, because of their considerable inaccuracy in reading peak levels but they are useful when the Revox is driven from an external mixer.

Next month an accurate method of setting up the replay and record amplifiers will be described, which in principle can also be used for aligning many other industrial machines.

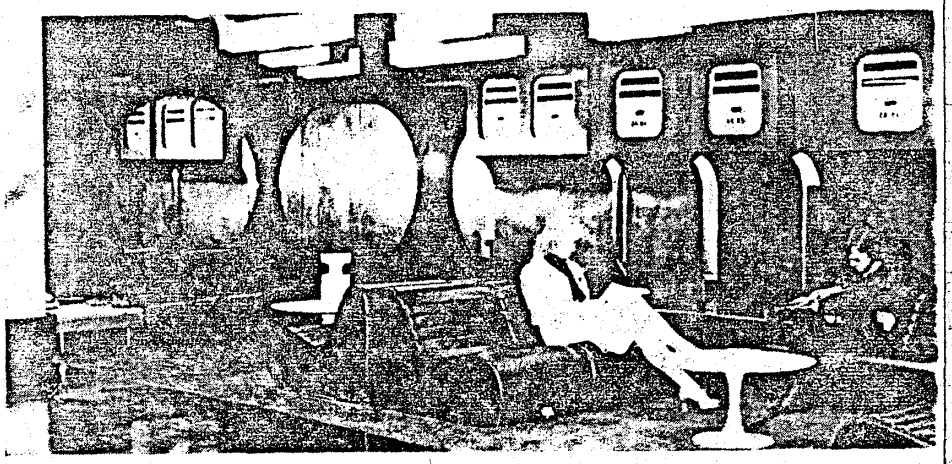
STUDIO DIARY

continued

singles, and David Bedford completing his album. Chris Barber laid down tracks with the Greaseband for his next album, and Jo Ann Kelly made a welcome return to the studio. Other artists have included Black Widow, Chas Peate's Pepper Box, Medicine Head, songwriter Kenny Pickett of *Grandad* fame, Richard Hewson, and the *Private Eye* team.

Future plans at Marquee include the enlargement of the studio by 37 m², and the rebuilding and extension of the reception area.

The **Jackson Recording Company** have been doing a lot of work for MIDEM, and have had several new customers in the studio recently. Songwriter and session organist Alan Hawkeshaw, who has played with Juicy Lucy, the Shadows and the London Symphony Orchestra, has been recording for the Ad-Rhythm label. Padlock Productions, a new company managed by ex-Checkmate Ken Street, have been using the studio, and Ray Brooks (of The Knack) and Mike King (of the King Brothers) have also been in. John Dunsterville, besides modernising the studio, has been doing a considerable amount of desk work.



Reception area at the new De Lane Lea Studios

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Part Two

By Angus McKenzie

I DESCRIBED last month some modifications which will greatly improve the flexibility of the Revox 77. This article describes the lining up procedure which should be employed to achieve the best overall results, a procedure also suitable for unmodified machines.

Before carrying out any adjustments whatsoever, the machine should be thoroughly demagnetised. This is best done by holding a bulk eraser over the tape transport rather than by using the normal small head demagnetiser which may well not have sufficient ac flux. Such demagnetising almost always removes the 'bubble' sometimes noticed with this machine when thick oxide standard play tapes are used. The replay amplifier should then be set up with the appropriate test tape. For this adjustment, the replay volume control should be set at maximum, the mode switch to stereo, the balance control to central and the correct equalisation position chosen. The replay preset gain controls should then be adjusted so that the peak level recorded at the beginning of the test tape gives a level at the auxiliary output phono socket of either +8 dBm or +4 dBm depending whether the test tape is DIN standard or Ampex standard operating level. Should a BASF NAB test tape be used, the peak level for some inexplicable reason is 320 pWb/mm and the level for this should therefore be set to read +8 dBm out. Test tapes produced to the American standard, or Dolby operating level test tapes, have the peak recording level at 185 pWb/mm and should thus be set to give +4 dBm. The reel of tape for which the machine is to be biased and equalised should then be loaded and the machine set to record with the record volume controls at minimum and both record track buttons down.

With the a/b switch in the replay position, the replay bias traps should be adjusted to give a minimum reading across the output sockets. Track Two usually has noticeably worse bias break-through than Track One, this being caused by the position of the printed circuit boards. This can only be improved by screening the bias reject coil with Mumetal (such as Telshield) and is frankly not worth bothering about. All preset adjustments for the replay traps should be done with the front metal cover screwed on and the cutouts punched through the paper label. If this cover is removed, the bias trap frequency will be changed due to the difference in capacitance.

The record bias traps may be checked by measuring the bias voltage chosen at the output of the record head driver stage (emitter/collector junction). The preset should be adjusted for minimum breakthrough at this point. Since I have never found the dummy loads incorrect, these are best left alone. A 10 kHz signal should now be applied to the auxiliary input and the recording level control increased with the a/b switch in the before tape position so that the output is +12 dBm with the replay gain at maximum. The a/b switch should be changed to the after tape position with the required equalisation. The bias should then be adjusted (labelled oscillator) at the appropriate speed. As a rule, the bias should be increased beyond the peak output at 10 kHz such that the output from the tape drops by between 2.5 and 3 dB. The difference in output between 1 kHz and 10 kHz should then be checked to make sure that the tape has been biased over peak rather than under peak at 10 kHz, the position giving the higher reading at 1 kHz being the correct one. After the bias has been set, the record equalisation should be adjusted to give the best overall response and this should be done under the same conditions with, again, an output from the machine of +12 dBm.

Record preset

The record preset level control should then be adjusted so that the same output level is obtained in both positions of the a/b monitor switch. A frequency of 1 kHz should then be applied to give a level of +4 dBm out in the after position of the a/b switch. At this level, the vu meter presets should be adjusted for zero. Both the a/b balance and the vu meter sensitivity, should be adjusted at the speed where the calibration is most important since at the other speed an error of up to 2 dB or so may be noticeable, especially if the Revox has been lined up for two different types of tape for the two speeds. A plastic, or metal tipped plastic, screwdriver should be used to adjust the meter sensitivity since a short circuit between the preset and the metal round the adjustment hole will short the ht supply and damage the main regulation power transistor.

As a rough guide, the treble response should be held to within ±1 dB at 38 and 19 cm/s and the same tolerance can be achieved for 9.5 on good quality tape up to 17 kHz, although particularly at the latter speed the accuracy of azimuth should be checked before setting up the record amplifier. The replay azimuth should be adjusted after the replay gains have been set with the replay mode switch in mono for the best compromise of accurate azimuth on both tracks. The record azimuth should be set by sending a 10 kHz signal, or better still white noise, such that the same intensity is replayed from each track separately, and at a playback level of not more than −6 dBm out. After adjusting the gains, the replay mode switch should be left in mono for the record head azimuthing.

It is hoped that these articles will encourage readers to improve the standards achieved on their Revox recorders and also facilitate the use of this model more generally in studios. With modifications described last month, the machine's performance approaches that of machines costing many times more, although careful maintenance may well be necessary if the machine is to work hard. As a rule, it will be found that the record and replay heads and the capstan will wear rather faster than would be normal with higher price machines. Wear is noticeable as a groove in the capstan where the tape passes over it. Both head and capstan wear are accelerated by the use of double play tape, which should be avoided for best results.

One final word of warning. My colleague Ren Hunter recently found that, if the machine is in the playback mode and the left hand spooling button lightly knocked by accident, the machine will sometimes go into the record mode. This is quite definitely not a sample fault since five different machines all produce the same result. It is therefore recommended that the record track buttons should be in their off positions when in replay mode.