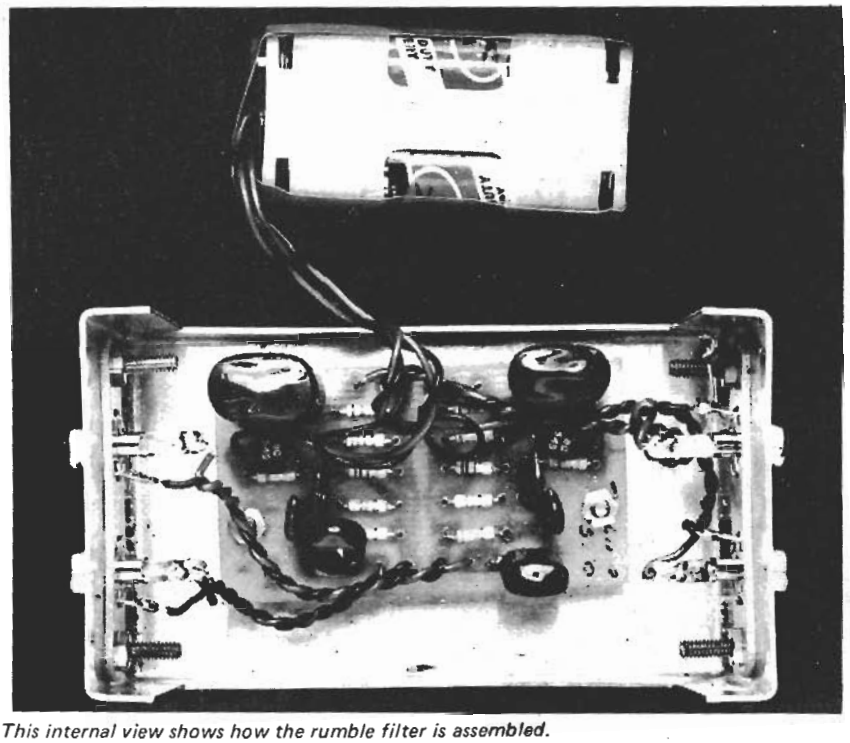
# STEREO RUMBLE FILTER



*This internal view shows how the rumble filter is assembled.*

**Active filter design improves clarity of bass reproduction.**

IN BYGONE DAYS rumble filters were very popular because even the best of turntables, used then, generated considerable vibration due to bearing and motor deficiences. These vibrations, mechanically transmitted to the pickup cartridge, resulted in an audible output. Hence high-pass filters were often incorporated in amplifiers to reduce this objectionable rumbling sound to an acceptable level, and as bass response seldom extended below 50 Hz, a simple RC filter with 6 dB per octave roll-off below 50 Hz was considered adequate.

Modern turntables have far smoother bearing and drive arrangements than their early counterparts – and for this reason many amplifier manufacturers no longer include a rumble filter facility.

Those that do are rarely satisfactory. Their slope is generally inadequate and the main effect of switching them in is to roll off the low-frequency response to the detriment of programme content.

At first sight it would seem better to exclude the rumble filter altogether and just make sure that our turntables do not generate any appreciable rumble.

Surprisingly perhaps, a rumble filter is still very much required and if designed correctly can make an appreciable improvement to reproduction – even when used with turntables that generate no rumble at all!

The reason why will be clearly apparent if you take the front grille

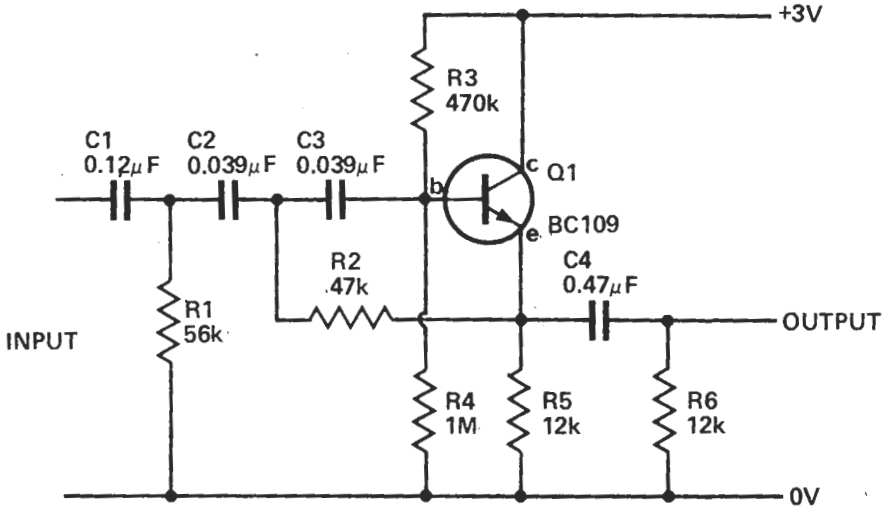



*Fig. 1. Circuit diagram of the rumble filter. Two required for stereo.*

## HOW IT WORKS

The filter consists of three separate sections:-

1. A passive RC filter consisting of R1 and C1.
2. An active filter comprising C2, 3, R2, 3, 4 & 5 and Q1.
3. A passive filter comprising C4 and R6.

The active filter (from input of C2 to output to C4) is a standard design with the exception that values have been selected to give a peak in the response at the cut-off frequency. The maximum lift is about 2 dB and this characteristic, combined with those of the two RC filters, gives a sharp knee to the roll-off. The composite filter has a lift of 0.2 dB before turning over sharply.

Thus low frequency response is maintained substantially flat down to 50 Hz and is only 2 dB down at 40 Hz. Thereafter the response drops very rapidly and is in excess of 30 dB

off one of your speakers and – with the phono-cartridge tracing a section of record that has no recorded content (or very low level content) – turn the volume control up fairly high. You will almost certainly find that the cone of the bass driver is making wild excursions to and fro, probably at frequencies between 5 Hz and 15 Hz.

So it's sub-audible – why then does it matter?

Well it really does – and we'll explain just why later in this article – but first let us consider just where this 5 Hz – 15 Hz content comes from.

Firstly, modern turntables and arms have mechanical resonances lying within the 5-15 Hz region. Secondly, stereo cartridges are sensitive in the vertical as well as horizontal planes and will respond to uneveness in record or turntable surfaces. They will also respond to a defect in the record surface known as pressing rumble.

In addition the noise finds its way onto the record during the actual recording process. This recorded noise is due to LF noise and rumble sometimes being induced in the recording lathe by seismic disturbances, and by vibration in drive gears and cutting head carriage rails.

Lastly vibration of a low frequency nature, due to people walking past the turntable or vehicles passing by outside, may well excite the turntable and arm resonances even though the turntable is reasonably well sprung.

## WHY SUB-AUDIBLE NOISE MATTERS

This very low-frequency noise is responsible for a remarkable amount of intermodulation distortion which generally makes the bass sound muddy. In extreme cases it may cause the reproduction to sound as if speaker cone break-up is occurring. The reasons for this are as follows.

Preamplifier stages usually have two or three transistors around which large negative feedback is applied for equalization and/or tone control. At sub-audio frequencies these feedback networks are not generally effective. Thus the LF signals may well receive considerably more amplification in the preamplifier than would normally be expected. Secondly although the magnitude of the LF signal may not itself be sufficient to overload the preamplifier, the combined LF and music signals may well cause the preamplifier to clip. Even if clipping does not occur the LF signal will cause intermodulation distortion despite the fact that the LF signal is inaudible!

Most modern power amplifiers are quite capable of amplifying this noise signal, presenting it to the loudspeaker at a surprisingly high power level. The speaker itself has very little acoustic loading at these low frequencies and the cone will thus move considerably and may even be driven beyond its linear excursion region. Even if not actually overdriven, the presence of such large cone excursions will produce a high level of intermodulation distortion.

Whilst elimination of factors causing the noise is by far the best procedure, a lot of these factors are completely beyond the control of the average hi-fi owner. Hence a rumble filter would seem to be the obvious answer. But, we do not want to sacrifice any low frequency response and we want signals in the offending 5-15 Hz region to be attenuated as far as possible – two apparently conflicting requirements. In addition, as LF noise cannot be allowed to enter the equalization stages of the preamplifier,

### PARTS LIST

| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 56k | ¼W | 5% |
| R2 | " | 47k | " | " |
| R3 | " | 470k | " | " |
| R4 | " | 1M | " | " |
| R5,6 | " | 12k | " | " |
| C1 | Capacitor | 0.12µF | polyester | |
| C2,3 | " | 0.39µF | " | |
| C4 | " | 0.47µF | " | |

Q1 Transistor BC109 or similar

* for stereo 2 off each of the above parts are needed.

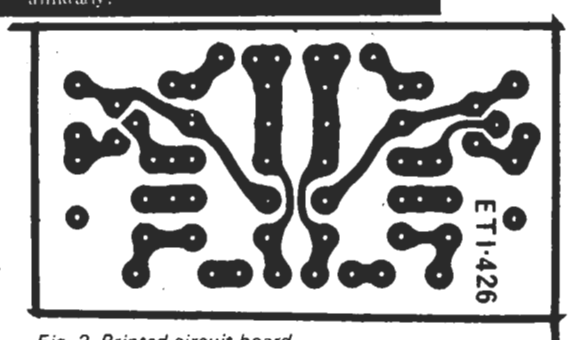
PC Board
2 dual phono sockets
2 dual battery holders or one 4 way holder.
4 1.5V batteries.
2 8mm long spacers
1 small aluminium box.

### SPECIFICATION

| | |
|---|---|
| Input Impedance (rises below 50 Hz) | 47k |
| Output Impedance | < 5k |
| Input voltage (maximum) | 250mV |
| Cut-off Frequency (–3dB) | 36 Hz |
| Cut-off Slope (maximum) | 24dB/octave |
| Attenuation at 10 Hz | 37 dB |
| Gain at 1 KHz | –0.2 dB. |

down below 15 Hz where most LF noise occurs.

Current drain of the two filters is only 100 µA and the batteries will last their normal shelf life of about 12 months, thus no power switch is required. Batteries should be replaced annually.



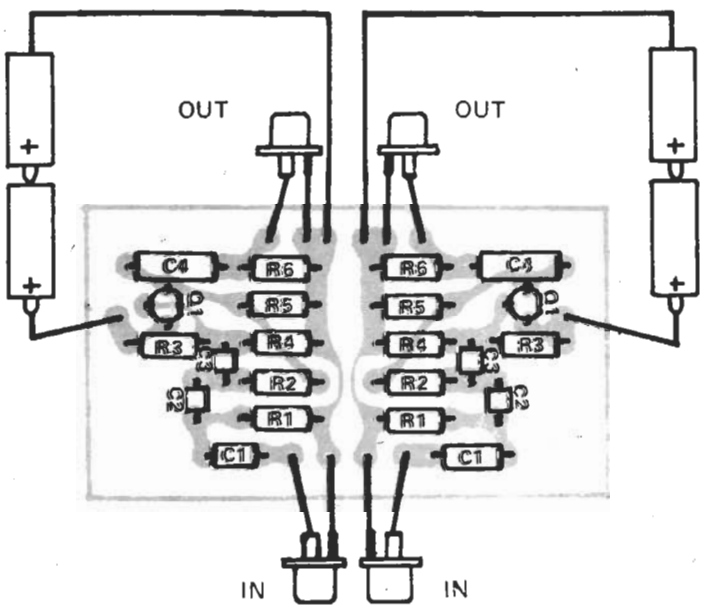




*Fig. 2. Printed circuit board layout for the rumble filter 40mm x 70mm.*

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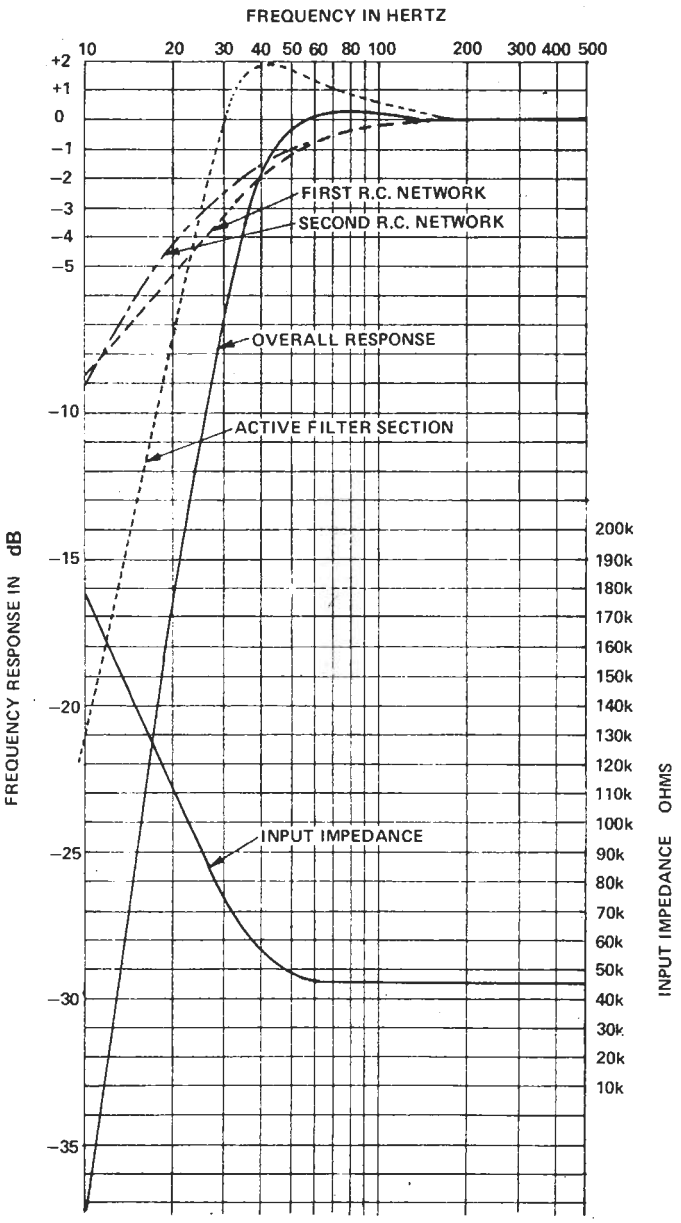


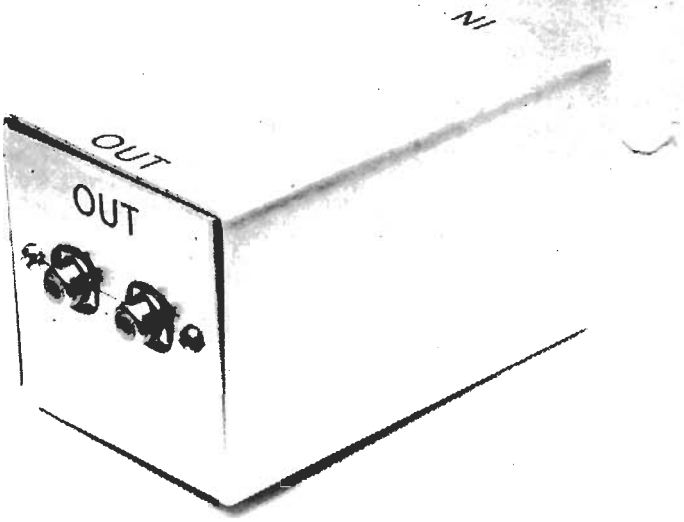


*Fig. 4. Characteristics of the rumble filter.*

the filter must be situated before the preamplifier. This also poses problems as the signals at this point are very low-level, and there is a danger of introducing hum which would be merely replacing one fault by another.

## THE SOLUTION

To maintain response down to at least 50 Hz, whilst obtaining 30 dB or more attenuation to LF noise, we must use a filter which has a sharp knee and an ultimate attenuation slope of 24 dB per octave. The most satisfactory (and cheapest) method of doing this is to use an active high-pass filter – and this is the approach we have used. To obviate the possibility of hum-pickup, the unit uses a battery power supply, one each for left and right channel filters. The use of separate batteries prevents earth loops and ensures that channel separation is maintained. As current drain is very low the batteries may be expected to last their shelf life (12 months or so) and for that reason an on/off switch has not been included.

The unit fits between the turntable and the amplifier, cuts any frequency below 35 Hz and has a total attenuation of 37 dB at 10 Hz increasing at 24 dB/octave below that.

## CONSTRUCTION

We built our unit onto a small printed circuit board, but layout is not critical and other alternative methods, such as matrix or Veroboard, may be used successfully.

The signal levels involved are extremely small (about 100 $\mu$V at 50 Hz) and for this reason a metal box is a must if hum pickup is to be minimized. And, as said before, two separate battery supplies should be used in order to avoid earth loops. We used a conventional four-way battery holder to hold the two sets of batteries. These holders normally connect all four batteries in series. However it is a simple matter to snip the connection between the two sets of two cells.

The phono sockets for both input and output should be insulated from the metal case. When connecting the unit we found minimum hum was introduced by earthing the turntable to the metal box and then, by taking a separate earth from the metal box to the amplifier. However experimentation in the positioning of earths may well show that some other configuration is best for your particular setup. ●