Advanced preamplifier additions

Rumble and scratch filter, virtual earth mixer, meter suppression circuit

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This article describes a number of additional facilities that may be easily added to the preamplifier design published in the November 1976 issue of *Wireless World*. These additions are in the form of independent circuits, one or all of which may be added to a completed preamplifier with a minimum of disturbance to the existing circuitry. Even if all the circuits are incorporated, the extra demands on the stabilized power supplies should cause no problems.

The original design did not include a scratch or rumble filter because it was felt that an attempt to make no compromise in the range of facilities provided, as well as in performance, could lead to a design that was over-complex. Furthermore, use of the treble control in the 5kHz setting was thought to give some of the advantages of a variable-slope scratch filter. Nevertheless, the ultimate slope is only 6dB/octave, and therefore the high-frequency rejection is less than that obtainable with the usual second-order low-pass filter. It should also be noted that the low-frequency response of the original preamplifier was not extended to d.c., but rolled-off in a controlled manner to be 3dB down at 7Hz. However, a good deal of interest has been shown in further filtering facilities, and therefore the design shown in Fig.1 was evolved. This uses a switched-frequency second-order low-pass filter, and a fixed-frequency third-order high-pass filter that discriminates against the subsonic disturbances generated by record warps etc. The last mentioned is not really a rumble filter because it does not attenuate within the audio band. The frequency response is —1dB at 20Hz and —17dB at 10Hz, hence subsonic signals are greatly attenuated without perceptible loss of lower bass frequencies. The filter has a Butterworth characteristic. The low-pass filter incorporates switch-selected cut-off frequencies at 10kHz and 7.5kHz as measured at the —3dB point. These frequencies were chosen after listening to records suffering from varying degrees of damage and wear, and are believed to be a good compromise. The 10kHz filter has a relatively subtle effect which gives a smoother upper frequency response with records that are only slightly past their best. The 7.5kHz setting is effective with more severe cases, while discs in very poor condition may be improved by the use of an even lower cut-off frequency using the treble control. Restricting the low-pass filter to two switched frequencies allows the use of a 3-way, 4-pole rotary switch. With the switch in the out position the low-pass filter still operates but the —3dB point is at 40kHz. This prevents

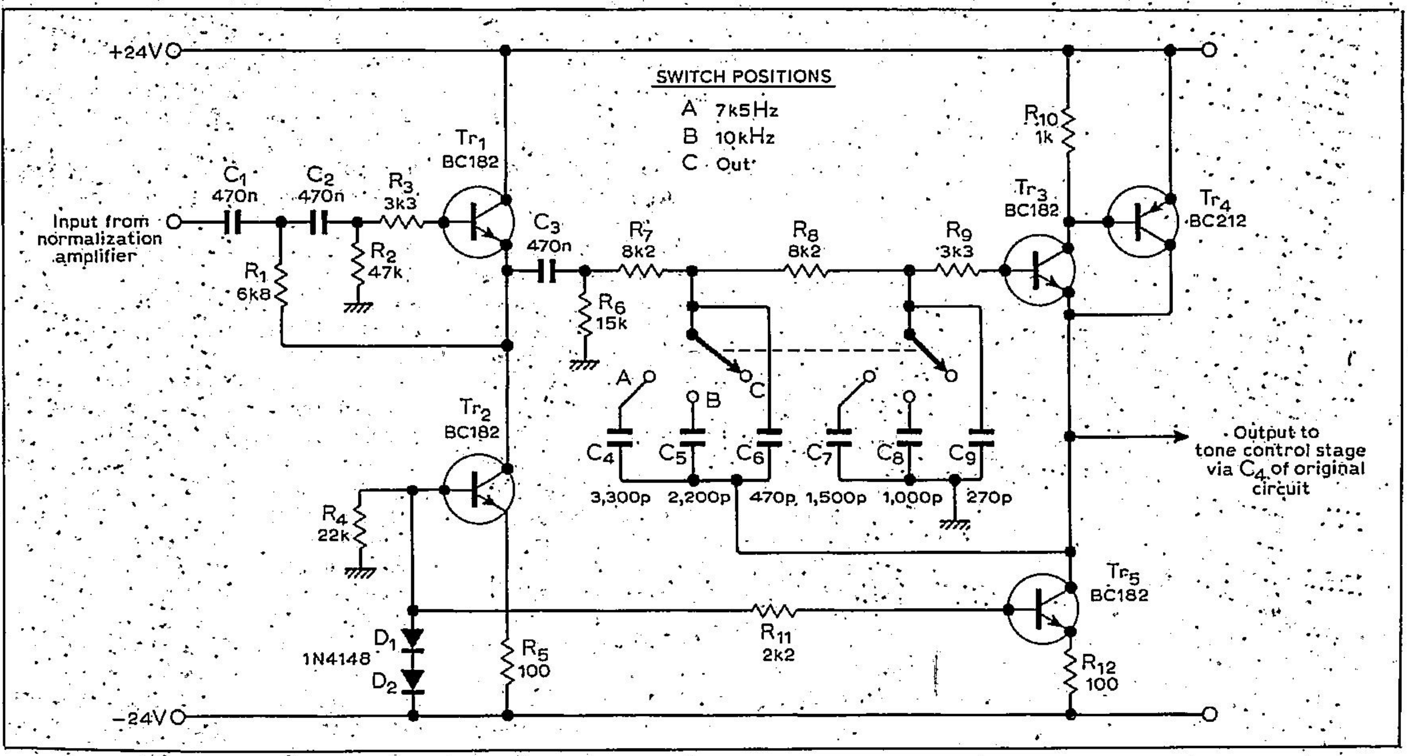

Fig. 1. Rumble and scratch filter. This circuit has a switched frequency low pass stage and a fixed frequency third-order high pass stage.

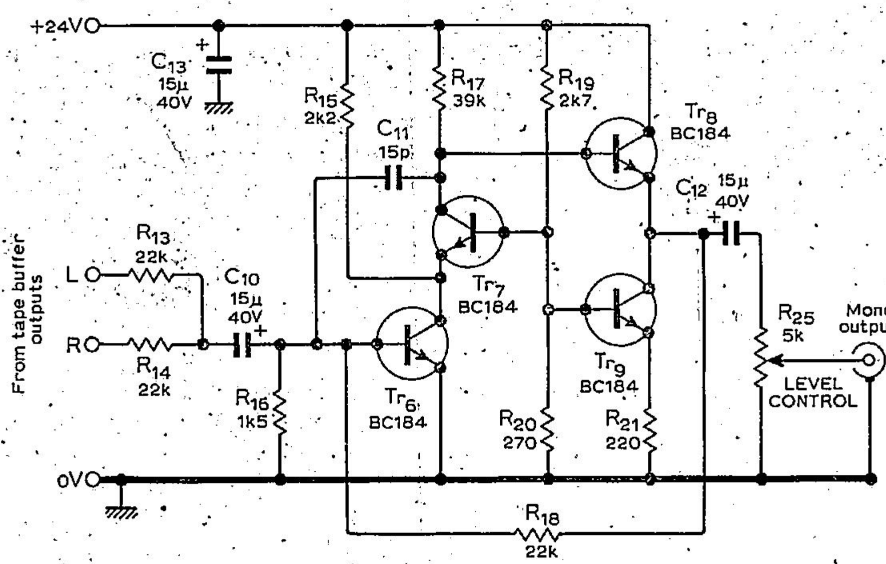

Fig. 2. Virtual earth mixer. This circuit allows simultaneous stereo and mono signals from the original preamplifier.

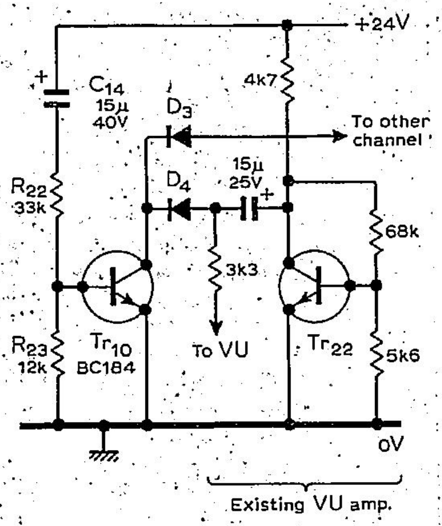

Fig. 3. Meter suppression circuit.

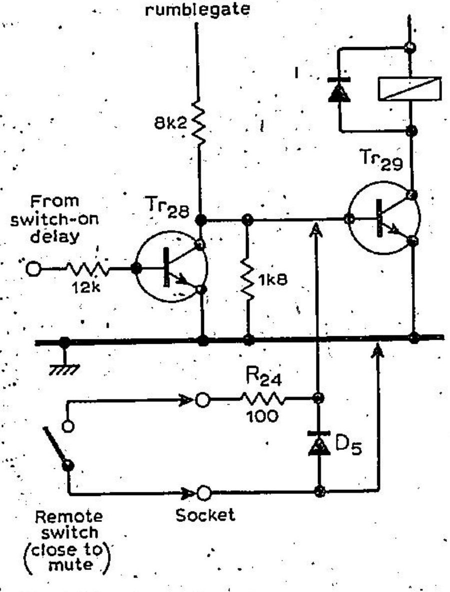

Fig. 4. Remote muting arrangement.

out-of-band frequencies from being fed to the power amplifier, which could cause t.i.d.

Both high and low-pass sections use the well-known Sallen & Key configuration, with unity-gain buffering provided by emitter-followers with current-source loading. As described in the original article, current-source emitter-followers generate very low levels of distortion and have better load-driving characteristics than conventional emitter-followers. Both current sources are biased from diodes D_1, D_2. Resistor R_{11} prevents Tr_5 from affecting Tr_2 in the event of a fault. The prevention of interaction makes fault diagnosis much easier. One point of interest is that the final unity-gain buffer is in fact a compound emitter-follower incorporating a complementary pair. This is desirable because the second unity-gain buffer, unlike the first, is driven from a substantial resistive source impedance, and under these conditions a simple emitter follower would generate a relatively high level of t.h.d. The circuit shown produces a t.h.d. figure of about 0.008% for 12V r.m.s. at 1kHz.

It is recommended that the filter is connected between the normalization amplifier and the tone-control stage so that the filters come immediately before C_4 on the original diagram. Note that the feed to the rumble gate must be taken off before the filters because the detection of subsonic frequencies is fundamental to the correct operation of the gating circuitry. The signal to the tape output emitter-followers may be taken before or after the filter system. A stereo filter draws an additional 30mA from the two stabilized supply rails.

The original preamplifier design had no provision for mono/stereo switching, as it was felt that it was unlikely to be used with a mono power amplifier/speaker system. It should also be appreciated that mode selection circuitry that does not compromise headroom or distortion performance in either mono or stereo would add a significant amount of circuitry to the preamplifier. The prototype preamplifier has now been in regular use for over a year, and in this time the only real need for a mono output has been for recording stereo material on a single-track tape machine. It was therefore decided to design a virtual-earth mixer that would give a mono tape output while the main preamplifier outputs remained in stereo. This simultaneous mono approach has the advantage that it can be easily added to an existing preamplifier without the need of a mode switch on the front panel. The prototype mono mixer incorporates an internal preset for controlling the output level. This can be brought out to the front panel or omitted as required.

The circuit of the mixer is shown in Fig.2. Mixing resistors R_{13} and R_{14} are fed from the existing tape buffer outputs, see Fig.3. of the original article. Shunt feedback is applied through R_{18} to give unity voltage gain and a virtual earth point at the junction of C_{10} and R_{16}. The design is derived from a configuration described by Butler[1] and offers a very low t.h.d. figure without the use of the usual circuit artifices such as bootstrapping or current-source collector loads. At an output level of 5V r.m.s. the t.h.d. is below 0.005% from 1kHz to 20kHz. Transistors Tr_6 and Tr_7 produce all of the voltage gain and are arranged as a cascode. Resistor R_{15} bypasses Tr_7 and allows Tr_6 to operate at a much higher current level than the collector load R_{17}. This arrangement appears to be crucial for good distortion performance. Transistors Tr_8 and Tr_9 operate as the now-familiar current-source emitter-follower so that low-impedance loads down to 3kΩ may be driven without loss of headroom due to premature clipping on the negative half-cycle. Note that current-source Tr_9 is biased from the same potential divider as Tr_7. The mixer circuit draws an additional 26mA from the +24V rail.

When the prototype preamplifier is switched on, the VU meter needles smartly strike their end-stops and then fall back. This behaviour is due to the initial charging current of the 15µF capacitor, coupling the collector of Tr_{22} to the meter, see Fig.3, passing through the meter movement itself as the supply rail rises. The degree of overload does not appear to be excessive as no degradation of meter accuracy has occurred during the past year. Nonetheless, the sound of meter needles against end-stops is not pleasing and the circuit shown in Fig.3 has been provided to prevent this effect. At the moment of switch-on, the +24V rail rises rapidly and current flows through C_{14}, R_{22} and R_{23}, to turn on Tr_{10}. This transistor shorts the switch-on surge to ground via D_4, and reduces the overswing to an inoffensive twitch. After a few hundred milliseconds C_{14} becomes fully charged and insufficient current flows through R_{22}, R_{23} to keep Tr_{10} conducting. The transistor then

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turns off and has no further effect on the VU circuitry. Diodes D_3 and D_4 isolate the two VU circuits from each other and also prevent Tr_{10} from being driven into conduction on negative half-cycles.

A further point about the VU system, which should have been emphasized in the original article, is that the 10kΩ resistor and germanium diode associated with the meter itself are only relevant if inexpensive milliammeter movements are fitted. If professional VU meters are used, which contain internal bridge rectifiers, the above components are unnecessary.

Because the amplifier is already fitted with a relay that switches off the main outputs, it is simple to add a socket for remote muting. Fig.4 shows part of the original rumble-gate system, together with the new components required. All that is involved is the closure of a switch between the base and emitter of Tr_{29} so that the transistor turns off and causes the relay contacts to open. Note that, like the switch-on delay, this facility overrides all other control functions. The resistor and diode are included to protect the circuit if a wrong connection to the remote-muting socket is made. As the control lead only handles a small direct voltage the audio signal cannot be degraded.

Reference

Butler, F. Transistor wide-band cascade amplifiers, *Wireless World*, March 1965, pp.124-128.

Printed circuit boards

A p.c.b. which accommodates a stereo rumble and scratch filter, virtual earth mixer, and meter surge suppression circuit, will be available for £3.50 from M. R. Sagin at 23 Keyes Road, London N.W.2.