

THAT ANNOYING HUM...

and what you can do about it

There is more to wiring a record playing deck than simply attaching shielded output leads from the pickup and a 3-core power flex for the motor. Sometimes these leads can interact to produce an unexpected source of hum in a hi-fi system.

by NEVILLE WILLIAMS

This article was triggered off by a situation which one of our staff members encountered recently, in a private capacity. It reminded us of letters which come to hand from time to time indicating that the problem, while not common, is certainly not unique.

The case in point involved a stereo playing deck, an amplifier and a pair of loudspeakers which an enthusiast had purchased separately and connected together. The system worked well except for one particular fault: When set for normal listening level in the room, an annoying mains hum was evident between tracks on the record and during the quieter musical passages.

If any attempt was made to use bass boost, the hum level became quite objectionable. The problem was to isolate the cause and effect a cure.

Seemingly the amplifier was not at fault, since unplugging the pickup leads while leaving the volume control untouched

removed all signs of the hum.

There was an alternative possibility of the hum being induced from the motor windings into the cartridge but another routine observation largely eliminated this possibility. With everything operating normally, the pickup was raised just above the surface of the disc and swung from its rest position towards the label. With induced hum, the level would almost certainly have varied with position; in fact, the hum level was completely independent of the position of the head relative to the turntable.

This pointed to the third — and most likely — cause: a hum loop involving the turntable power lead. Sure enough, inspection of the underside of the player revealed the classic hum loop situation, as illustrated in Fig. 1.

Four fine leads from the base of the pickup were terminated on a 3-lug tagstrip, the two "earthy" or common leads going to the centre lug. This lug was extended in the usual way to provide a foot which was

bolted to the frame of the player. From the tagstrip a length of shielded twin wire was provided for connection to the amplifier, the braid being soldered to the centre lug.

Fig. 1 also indicates the power wiring underneath the player deck. Ignoring the off-on switch, wires from the motor ran to a junction block, which also terminated the incoming 3-core power flex. The earth wire was anchored to a lug bolted to the player frame. Electrically the manufacturer had done the right thing, but not without implications in regard to the signal circuit.

Tracing the path from pickup to amplifier, signals from the cartridge first reached the 3-lug tagstrip, at which point the two "earthy" leads joined together and made contact with the frame of the player. From here they ran to the amplifier through a shielded twin pair, with the braid providing common path for the "earthy" side of both cartridge elements. In isolation, this connection would not normally have involved any problems.

However there is another return path for the signals, paralleling that provided by the metallic braid. It runs from the centre lug of the 3-tag strip, through the body of the player to the lug to which the motor wiring is bonded. It then runs through the 3-core power flex to the power point earth, and wiring, and from here back through the amplifier power cord to the amplifier. Inside the amplifier it bonds to the chassis at some point adjacent to the power supply, finding its way back to the actual signal input circuit via the internal metalwork and wiring.

There are thus two distinct paths by which signals can be conveyed to the amplifier input: one intentional and direct, the other via the power wiring. When this occurs there is a strong chance that stray hum components present in the power wiring will find their way into the signal circuit and this, in fact, was what was happening.

Considered another way, the two earth paths may be regarded as forming an "earth loop".

Starting, say, at the centre lug of the 3-tag strip, one can trace a continuous path through the power cord to the power point, through the second cord to the amplifier chassis and thence back to the tagstrip via the braid. It constitutes a large single-turn loop, into which currents can easily be induced from stray fields surrounding power wiring, power transformers, &c.

It is this induced current and voltage which can get into any low-level signal circuits associated with the hum loop.

Use of the term "low level" in the preceding paragraph is significant. The kind of wiring described might not lead to any problems in a player fitted with a crystal or ceramic cartridge, because the induced hum voltage would be very small in comparison with the signal from the car-



Modern high quality turntables such as this Sony unit are extremely unlikely to be plagued by hum problems. Owners of older units may not be so fortunate.

tridge and the input sensitivity of the amplifier.

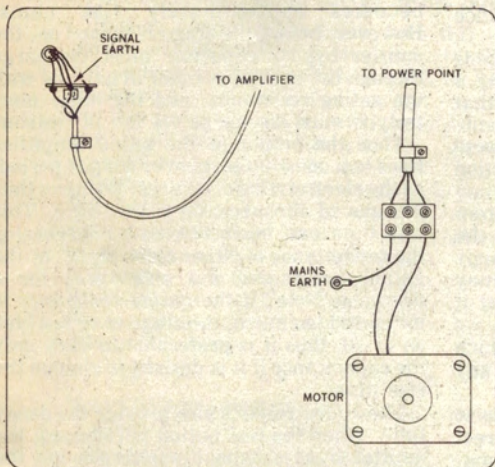
But with a magnetic cartridge having an output of only a few millivolts, and with a high-gain amplifier to match, small hum voltages induced in an input earth loop can be quite sufficient to produce an audible hum in the loudspeakers.

Fairly obviously, the earth loop situation in Fig 1 can very simply be interrupted by disconnecting the earth link from the power point to player frame — an easy way out and one that is often taken.

In fact, overseas record players are often manufactured on the assumption that only a twin power cord will be used. The problem of the earth loop arises when a 3-core flex is fitted, in accordance with Australian safety practices.

The chance of receiving a traumatic shock from a record player in a domestic hifi situation is probably quite small but the fact remains that elimination of the earth link to the power point does leave open the possibility. The fine earth braid back to the amplifier input can scarcely be regarded as affording significant protection, since it would be just about as likely to "blow" as the fuse in the event of trouble.

In many cases it will be found that the



LEFT: Fig 1, showing the wiring situation likely to be found under a player deck when hum problems exist.

motor itself is insulated from the frame of the player, being hung in rubber grommets and driving the turntable through a non-conducting belt or pinchwheel. If this is so, the frame of the motor can be earthed separately to the power point, leaving the rest of the metalwork to be connected to the amplifier.

While this offers adequate protection against an insulation breakdown in the motor, it does not protect against breakdown in the off-on or auto-stop switching. However, it may be possible in such a case to bond the player frame to the amplifier chassis with a fairly stout lead, without running into troublesome earth loop problems. The amplifier earth would then provide earth protection with the equipment set up for normal operation.

By far the best approach, however, is to leave the earth wiring to the power point intact and to modify the wiring to the pickup, so that the "earthy" side is completely independent of the metalwork of the player.

In the simplest terms this would merely involve replacing or supplementing the existing tagstrip to provide another anchor point for the earthy side of the pickup wiring, which would be insulated from the

player baseplate. Provided the wiring from the cartridge was completely independent of the headshell and arm and provided a plastic sheathed output cable is used, there can be no contact between the signal circuit and other metalwork and therefore no risk of an earth loop.

In fact, having become involved in modifications, there is good reason to go the whole way and to wire the pickup output circuit as shown in Fig. 2.

A tagstrip is required which will provide insulated terminations under the player for all four leads from the cartridge and, preferably, for the shield braids. Insulated and shielded twin leads should be provided for connection to the amplifier. The free ends must, of course, be fitted with the appropriate connectors and here the braid can be joined to the earthy side of the respective channel inputs.

Wired thus, there will be no connection between the signal circuit and the player frame, and the output from each half of the cartridge will be earthed only at the input point to the amplifier.

Not only does this avoid any kind of earth loop but it also has another potential advantage. The leads to each half of the cartridge are symmetrical and remain

dispensed with, do so; but otherwise it can negate efforts to isolate the pickup wiring from the player frame.

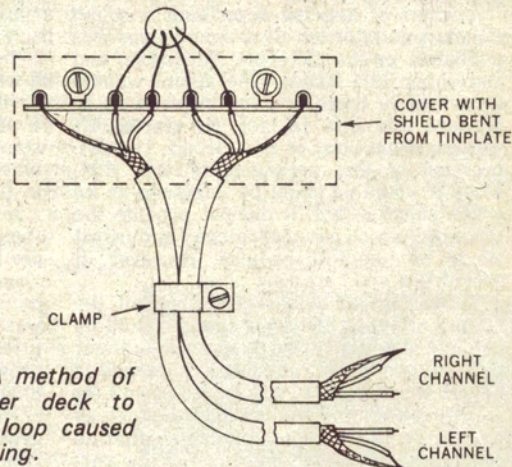
A second possibility is some kind of a link between the pickup wiring and the arm where the head or head shell plugs in. This link should be broken if at all possible to isolate the signal circuit. If not otherwise grounded, the headshell and pickup arm should be bonded to the motor frame and earthed back to the power point.

The remaining and most difficult problem occurs if the wiring from the cartridge through the arm is run in fine non-insulated shielded wire. The braiding, connected to the respective halves of the cartridge, is free to contact the inside of the arm and the vertical bush on which the arm rotates.

It may be possible to replace the shielded wire with four plain leads but these must be extremely fine and flexible (as used in other pickups) otherwise they will stiffen the movement of the arm both vertically and horizontally.

If the leads cannot be changed for any reason, the options become rather limited:

- Retain the earthing to the power point and put up with the earth-loop hum;
- Eliminate the earth wire and the hum



RIGHT: Fig 2. A method of rewiring a player deck to eliminate a hum loop caused by multiple earthing.

very close together inside a shield braid. Any hum field in the vicinity will tend to induce similar and in-phase currents in the two wires; and since the wires are virtually in series with the signal path, the currents will tend to cancel.

It is exactly the same kind of thinking which is applied to balanced and shielded microphone cables.

If there is a special reason to do so, the braid could be earthed to the frame of the player and not commoned at the amplifier end. Again, a 4-lead single-shield cable could be used with the braid earthed either at the player end or the amplifier end. There may even be cases where the braid could be used to advantage to link the player frame to the amplifier.

The important point, however, is to run the pickup wiring right through to the amplifier and to avoid having the braid as part of the signal carrying circuit.

Three possibilities occur to the writer which might complicate the intention to eliminate hum loops.

The first is the possibility of the cartridge carrying a link between the earthy pins and an outer metal shell. This could establish a contact with the player body via the headshell and arm. If this link can be

loop but forgo the protection that the earth wire affords against possible faults in the mains circuitry.

● Insulate the arm from the rest of the motor baseboard, but difficult with a metal baseplate. If this is done, the arm will be grounded via the signal wiring and the rest of the mechanism via the power flex.

● Eliminate the earth connection via the power point but bond the player frame effectively to the amplifier chassis, earthing the whole through the third wire in the amplifier power cord. This does not eliminate the earth loop problem but it does minimise it. The approach makes most sense when the phono motor picks up its power from the amplifier (via a built-in AC outlet) or from the same power point; this way, power to the motor is cut off when the amplifier plug is withdrawn.

A rather tedious business? We completely agree.

But then, a persistent background of hum in a hifi system is also rather tedious and trying. If you can eliminate it by the means outlined in this article, you will almost certainly judge the effort to have been worthwhile!