

# Harrassed by hum loops?

When hum bugs your system you can comfort yourself with the thought that even professionals have the same trouble — but that doesn't help you much! However, hum is generally solved quite easily — as long as you know what to look for.

THE MOST COMMON IRRITANT in hi-fi systems of any performance or cost standard is almost certainly hum, that horrible, low pitched noise which strikes almost every system at least once in its life. In fact, the only good thing that can be said about hum is that it is not selective; it will strike both amateur and professional equally.

And the most aggravating thing about hum is the trouble that it may cause — not that it will normally damage components unless extremely bad, but because it may sometimes take hours of concentrated searching to track it down. Until the cause is located and the problem corrected, satisfying listening is impossible.

## What is hum?

Once hum has been heard it is unmistakable.

It is also difficult to describe. Typical textbook descriptions run pretty much as follows: 'HUM — an unwanted low-pitched sound produced in reproduction by an interference from the

ac mains. It usually occurs at the mains frequency of 50 Hz, or at its second harmonic, 100 Hz. Can be caused by . . .', and then follows a list of about a dozen typical causes.

In spite of the rather open-ended descriptions, hum is immediately recognisable.

Its causes are not so easily pinpointed, although the sources of hum found in hi-fi systems can usually be traced back to any one of three chief sources — loops, screening and induction.

Hum generally affects low level signals with high circuit impedances — so the pickup cartridge and its associated signal connections are the prime offenders. The high gain of this circuit, and the large amount of bass boost applied in the RIAA equalisation, make it exceptionally prone to hum from any of the various causes.

In Australia, the ac mains power supply is a nominal 240 volts, alternating with a frequency of 50 Hz. Wherever these voltages occur, the mains conductors are surrounded by electrostatic and magnetic fields which fluctuate

at the same frequency. With a voltage as high as 240 volts, these fields are fairly intense, and can produce hum by inducing tiny ac currents in surrounding wiring and components.

Occasionally hum may arise from a faulty component in some piece of equipment, but most problems come from the linking and positioning of the hi-fi components.

## Loops

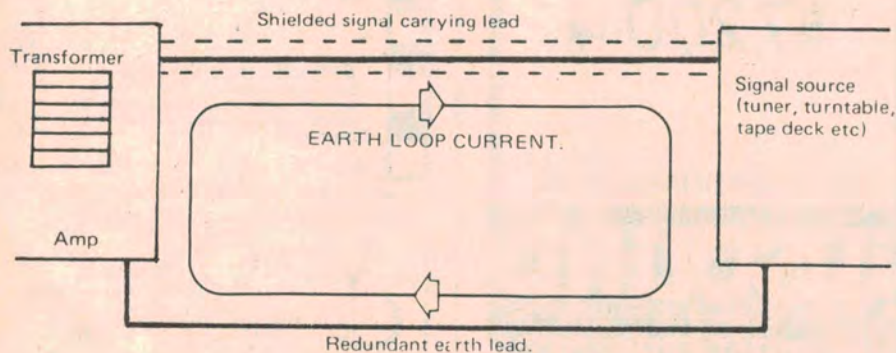
Earth loops are possibly the most common cause of hum, and are the most annoying in that they are frequently caused by taking too much care! They are formed by duplicating earth links between components — a real trap for beginners attempting to set up a foolproof system.

The problem arises when the earthed screen of a signal carrying lead is correctly earthed, but an additional earth link is formed between the two components. The separate earth link may be redundant, in which case it forms an electrical loop.

If there are slight potential differences at the earth points, or if the loop falls within a stray magnetic field, a tiny circulating ac current will start to flow within the loop. This current affects the audio signal carried in the central core of the conductor by adding unwanted components to it, and hum results.

Sometimes the loop may be formed through no fault of the person assembling the system. When the earthy sides of the signal connectors on the amplifier (or other component) are linked internally to form a common ground, a loop is very easily completed.

Troublesome loops are known as 'earth' or 'hum' loops, and although they are the common cause of a great many problems, their source may well be different in each case, and their cure may take considerable time and careful thought.



Earth, or hum, loops are set up when a redundant earthing link is formed between two components. The stray magnetic field around a transformer (in this case in the amplifier) can induce a small current in the loop. This tiny alternating current, flowing in the signal lead's shield is sufficient to produce unwanted components in the audio signal, and this is heard as hum.

The ideal interconnecting system between any two components conveys the signal and the earthy (signal return) conductors for each channel by only one path — via a live and an earthed conductor. Separate earth connections should be used only to earthed metalwork which is not connected to the signal carrying circuits. Because of this pickup arm on a turntable is earthed separately without causing hum loop problems.

In these cases earthing may be essential to draw off any leaked voltages or static build-up directly to the mains earthing point. If these spurious voltages were carried via the signal earth leads, they too could cause interference with the audio signal.

### Curing earth loops

As hum loops are set up when there is a redundant earth connection, they can be cured by breaking the loop — that is, by removing the redundant earth.

The process of tracking down a hum loop problem is rather long and laborious. If the majority of connections are made by RCA-phono plugs and sockets, it is rather more simple than when DIN connectors are used.

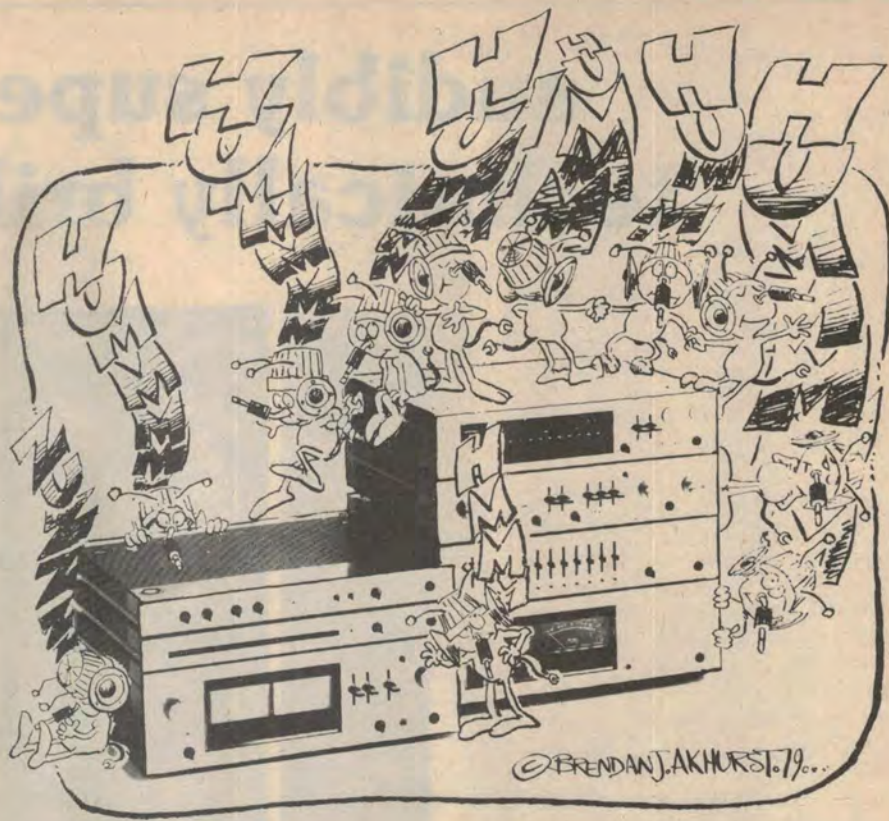
Start by disconnecting all inputs to the amplifier except for the separate earth link between the turntable frame and the amplifier's chassis. Connect one channel of the turntable and note the hum level. Try pulling the plug slightly out of the socket so that the outer rim doesn't still make contact. If the hum is now worse, push the plug fully home — excessive hum indicates that the rim contact is not redundant but is needed for shielding. If, however, the hum is reduced with partial connection, leave the plug as it is — this earth is redundant.

Now check the second channel from the turntable in the same way. If the hum is still present in spite of these checks, try removing the separate earth link from the frame of the turntable to the amp. It is unlikely that this will be redundant, as ideally it should be isolated from the signal carrying components. In rare cases, however, its removal may help.

Continue this checking process in the same way for all inputs, until you are sure which earth links are redundant and may be disconnected permanently.

DIN connectors pose more of a problem, and unless you are sure of your ability with a soldering iron it will be better to check only the auxiliary earth connections, and then investigate to see if the problem lies elsewhere.

When working through the checking procedure, make sure that the amplifier's



When those hum bugs get your gear, you're really gonna know it!

volume control is turned down whenever making or breaking contacts. High level transients are easily generated, especially when checking for loops in the vicinity of the turntable.

### Electrostatic hum

Because of the fairly intense electrostatic fields surrounding mains supply cables, any signal-carrying leads within such a field may be affected, because of the capacitance across the space between the cables. The higher the circuit impedance, and the lower the audio signal level, the more likely the occurrence of hum breakthrough.

This problem is generally overcome by the use of an earthed shield around the signal carrying conductors — hence the almost universal use of shielded leads for connections between components.

The screen must be arranged so that the live conductors are shielded by some earthed metal at all times — it will be seen when looking at RCA or DIN plugs and their appropriate sockets, that this requirement is fulfilled. It is to prevent this type of hum that almost all signal carrying leads between components in a hi-fi system use a shielded cable.

The shield, or braid, should itself be insulated so that it doesn't inadvertently contact any other earthed metalwork.

If this happens, the earth bypass created will form an earth loop to bring even more hum.

The only components which do not require shielded connecting leads for the audio signals are loudspeakers, which are fed by high level signals via a low impedance circuit.

While it may be an advantage to use earthed metal equipment cabinets as a shield against induced electrical hum, this is not possible when the cabinet is electrically connected to the equipment's chassis. In this situation, any separate earthing of the cabinet will form a hum loop — the cure may be worse than the original symptom.

### Curing electrostatic hum

The most obvious cure for hum of this sort is prevention. Any signal-carrying lead should be kept well clear of all mains supply cables, and should also be kept as short as practicable. However, as electric fields are coupled by capacitance, and the effects diminish as distance increases, length should not be sacrificed unnecessarily. Never lengthen the connecting cables supplied with a turntable, however, as this will degrade the unit's performance.

Mains cables should consist of

— continued on page 157. ▶

twisted conductors or, when using two core mains leads, paralleled conductors so that the fields are reduced by cancellation.

If it can be established that hum is caused by some form of electrostatic breakthrough, but it is not practicable to move the offending cables, a form of shielding may be required between the mains cables and the signal leads. Any earthed metal should serve the purpose — provided of course, it does not contact any signal leads and thus set up an earth loop.

When turntable hum is the problem, a trick of the trade which works in a surprising number of cases (with turntables fitted with two pin mains plugs) is simply to reverse the two pin mains plug in the power outlet — whether at the mains or at the amplifier's mains outlet. By transposing the active and neutral conductors in this way, it is sometimes possible to reduce the field that may occur around a switch, or some other internal device which is sufficiently close to the pickup, or to signal leads, to cause problems.

It is also worth experimenting with different routes for the signal cables — keeping them well clear of any cables carrying mains voltages. Make sure that any mains conductors are kept well away from the pickup cartridge.

### Magnetic induction

Transformers and electric motors operate within powerful magnetic fields

which are generated by passing the ac mains current through the windings of a coil. It is very difficult to contain the magnetic fields that occur around transformers or turntable motors, and they tend to spread out beyond the immediate vicinity of the device. Any coils (including earth loops) or windings used in signal carrying components which do fall within the stray magnetic field, are very prone to hum pickup of this type;

The earthed shield used to prevent hum from electrostatic fields is unfortunately no barrier to a magnetic field, and special metallic shielding — such as mu metal — must be used.

The components which are most susceptible to magnetic hum induction are the pickup cartridge and the magnetic heads on a tape recorder — low level devices which rely on magnetic coupling for their operation.

Generally tape heads are shielded by the internal design and layout of the recorder's electronics. However, the pickup cartridge by its very design and performance requirements must be close to the turntable's motor. While most good turntable motors do not give trouble, cartridges do vary in their sensitivity to magnetic fields, and troubles may occur when least expected.

In spite of any design features or in-built shielding included to prevent the breakthrough of magnetically

induced hum in turntables and tape decks, these units should be kept as far as possible from the power transformers of amplifiers, tuners and other components.

### Curing magnetic hum

The most common problem with magnetically induced hum is found around the pickup cartridge. To cure this hum it is necessary first to establish the cause.

If you suspect that the turntable motor is the cause of the problem, try switching the motor on when the arm is at different points across the turntable. If the hum appears and disappears as the motor is turned on and off, then the motor is the culprit.

It will be possible to tell where the problem is worst, and the only cure in some cases will be to relocate the arm. If this is impossible, as it would generally be with automatic and semi-automatic arms, it is necessary to look to some form of magnetic shielding.

If hum levels change with the position of the arm across the platter — even with the motor switched off — it is probable that some nearby component is the cause — possibly a power transformer in the amplifier or some other component nearby. Try changing the position of the turntable relative to the other components — sometimes a slight change in orientation is all that is needed.

Similar experiments will be required if the hum occurs in a tape deck, although this is only likely to occur when the equipment is mounted in a confined space such as an equipment cabinet.

### Halting hum

The search for the source of a hum may take a great deal of your time and when hum problems do arise, you must be prepared to devote several hours to the hunt. It is certainly worth while — you will not get any easy listening until it is found.

Remember that hum rarely comes from a faulty component so it is unlikely that you will banish it simply by buying replacement components.

Run through the major causes in a logical way and you should strike the root of the problem — eventually. But then you could always be lucky and find the source first time.

If hum does strike, don't close your ears to it and pretend that it's not there. It is a problem that has embarrassed many professionals, so if it strikes you, you'll be in good company! ●



Hum loops can be quite frustrating!