# Consider the turntable system . . .

A guided tour of modern turntable systems, their advantages and disadvantages and the dilemmas that face designers. Richard Timmins reports.

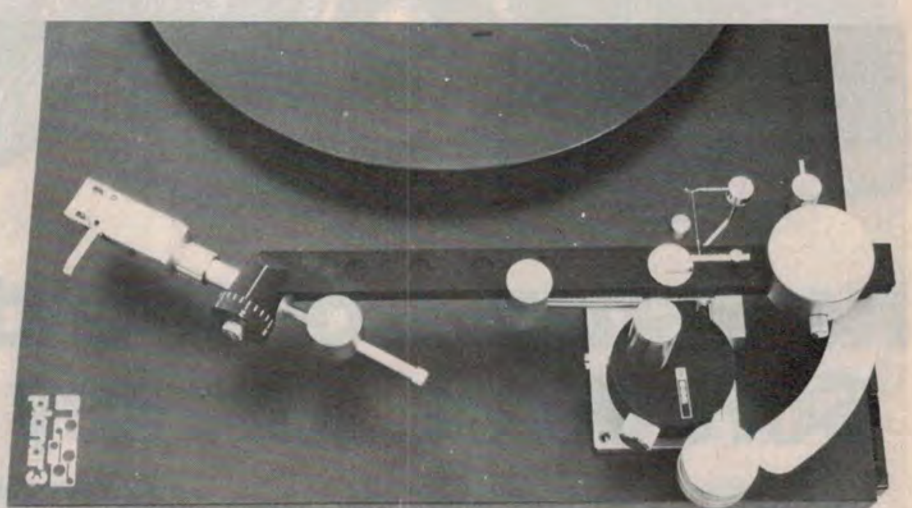
PERHAPS THE MOST interesting area of recent developments has been the turntable system, particularly in view of the major swing away from low-mass, high compliance pickup systems in favour of the apparently more old fashioned moving-coil systems.

The main limitation in low-mass pickups is the stylus itself, or specifically the effective tip mass of the stylus/cantilever system.

Some low tracking-force cartridges – the original ADC XLM is a good example – had ridiculously high compliance leading to inadequate tracking performance. The chief problem with such cartridges was applying sufficient tracking force to keep the stylus firmly in place in the groove; by its inertia, the stylus tended to lose contact with the groove walls and lack of stiffness in the suspension did little to control this.

Application of a higher tracking force (the XLM needed ideally, about 1.5 gm in the SME II arm), simply caused the stylus to retract into the cartridge body, especially when playing warped or rippled records – and most are these days!

Thus until there are significant reductions in effective tip mass, it seems most unlikely that very high compliance cartridges in low-mass pickup systems will offer the performance of a medium-compliance cartridge in a fairly massive, substantial pickup arm.



**Dynavector employ a massive arm in their model DV505 to reduce the effects of relative cartridge-arm movement, improving low level distortion.**

## Role of the pickup arm

This can perhaps be understood more clearly by considering the role of the pickup arm itself. The basic requirement is to hold the cartridge body completely still, to act as the stator in the generating system in which the stylus is linked rigidly (or so we hope) to the 'rotor'.

If the cartridge body is allowed to move in any way the required relative movement between the stylus/cantilever system will be modified and this will be reflected in the output, normally as a loss.

Some idea of how stable the cartridge body must be can be gained by looking at the actual size of low-level groove modulations – say, at -60 dB of maximum level.

Assuming a maximum groove deviation in the order of a millimetre or so, we're looking at mere thousandths of a millimetre at -60 dB; movement of this order in the cartridge carrying system will at best distort these low levels, at worst it will lose them entirely.

Dr Tominari, the mechanical engineer responsible for the Dynavector cartridges and DV505 arm tackled this problem by making his pickup arm very massive, adopting a neat ploy to reduce mass in the vertical plane without too great an overall performance compromise.

The general trend is, however, toward very rigid arms of medium-high effective mass. These are used with cartridges of low-medium compliance in which the effective tip mass is kept as low as possible to avoid mistracking problems due to inertia of the sylus.

The use of a fairly stiff stylus suspension ensures the arm/cartridge low frequency resonance is placed optimally beneath the lowest recorded audio frequencies and above the warp/ripple region. In the latter connection disturbance to the tracing performance, due to the fairly high overall inertia of the system, is thus minimised.

We can appreciate that the use of a low/medium compliance cartridge produces a situation where energy fed back into the arm is rather greater than when a high compliance cartridge is used. This is why a very rigid, non-resonant arm is therefore a must, and that necessary evil, the bearing system must also be very strong and tight to avoid unwanted resonances and spurious vibrations.

Other sources of unwanted resonance are the arm tube itself. This is prone to various forms of vibration such as structural resonances and reflections along its length arising from the cartridge. Then there's the counterweight system, usually decoupled from the rest of the system using a self-damped resilient material.

Fortunately, a heavy arm can possess ▶

a reasonably low effective mass provided the bulk of the weight is close to the pivot; it's interesting to note that many of the latest arms have enormous counterweights acting very close to the pivot where the moment of counterweight inertia is minimised.

## Vibration

Reduction of unwanted vibration at the stylus also depends on careful design of the rest of the turntable system. This is where so many direct drive turntables fall down in performance compared with certain belt drive designs.

The solution embodied in the Linn-Sondek LP12, and a number of other recent designs, is a most interesting one. On the assumption that engineering standards aren't high enough to achieve vibration levels some 60 - 80 dB below the maximum recorded levels (and in real terms this means relative movement of less than thousandths and millionths of a millimetre!) then a way must be found to couple whatever vibration there is to both record surface and cartridge body equally — it doesn't matter if the system moves as long as every part moves in the same direction at the same time.

In the Linn and similar designs, a very massive platter system rests on a finely-engineered bearing which, by use of an oil bath, prevents any relative movement between platter and the turntable sub-chassis. The sub-chassis itself is substantial and also provides a rigid platform for mounting the arm.

This fully-coupled system floats on undamped springs so as to prevent the introduction of feedback and other external vibration components. In theory, if the coupling is 100% effective, springing and other expedients for isolating external vibration shouldn't really be needed.

An alternative approach is to decouple both arm (using a resilient mounting) and record surface (using a thick, soft mat) as completely as possible, as a means of ensuring isolation of unwanted vibrations at either record surface or cartridge body.

## Direct-drive systems

Direct-drive turntables pose enormous problems becuase of the high levels of vibration resulting from the need to control rotational speed with a servo system.

To maintain correct speed, the platter must constantly go into error, thus producing a tiny vibrational product which is nevertheless of the same order as low-level recorded information. Many of the better direct-drives are, in reality, the worst offenders in this respect, correcting rotation as often as 1,000 times a second and therefore producing vibrations, of relatively high audio frequency, within the platter.

Because the platter, in its capacity as a rotor, is inherently decoupled from the chassis in a direct-drive system, there is little possibility of using a fully coupled system *a la* Linn.

Vibrations must be absorbed at some point between the point of their generation and the record surface. So, a must for direct drive turntables is a thick mat which damps the platter and absorbs vibrations. Unfortunately, complete decoupling seems to be a more difficult objective to achieve than complete coupling and the performance deficiencies characteristic of very many direct drive turntables are extreme sensitivity to mechanical and acoustic feedback and poor signal-to-noise ratio despite low rumble resulting from the use of very finely engineered centre spindle bearings.

## The pickup again

Returning briefly to the pickup arm, many of the latest models seem to be rather ahead of their time. Low-mass designs using carbon-fibre and very light metal tubes simply aren't rigid or heavy enough to accept most cartridges; as indicated earlier, the root of the problem is stylus tip mass, which must be reduced considerably before very high compliance cartridges can be operated with any real success.

Reduction of effective tip mass doesn't necessarily involve making the stylus itself lighter, although this is one area where improvements could be made, while allowing sufficient stylus shank length to enable accumulation of debris and dust without the build-up lifting the stylus out of the groove.

Shorter cantilevers and lighter armatures will also give worthwhile reductions, enabling suspension compliance to be increased. Cartridges of this type feed less energy back into the arm than low-medium compliance models, and thus can be used in these latest low mass arms.

Whether, on the other hand, it is actually desirable to develop a pickup compromise along these lines is arguable. The great beauty of the better high tracking force (2.0 - 2.5 gm) systems is their ability to remain in contact with the groove walls even when encountering surface contamination that could deflect the stylus of a low force, low mass system.

Loss of groove/stylus contact allows the stylus to bump around due to its own inertia until contact is regained mainly through the restoring force of the suspension. The higher tracking force systems actually seem to suffer less from groove and stylus wear and tear largely because the stylus is in a constant-contact, low-wear situation.

Perhaps the best course would be to retain low and medium compliance suspensions whilst still pursuing the low tip mass ideal, shifting the compromise in favour of improved transient response due to the improved acceleration potential of a light stylus.

The greatest benefits would be reduced high frequency distortion, especially at high levels, and the possibility of reducing the area of contact between stylus and groove to give improved definition from inner grooves; reduced inertia of a very light stylus would obviously help relieve pressure on the groove walls in the dynamic situation even if high tracking forces were maintained.

A by-product of this attractive situation would be reduction of vibration in the record itself as a result of stylus motion.

But that's another story. ●

**Direct-drive turntables have good mechanical attributes but need good decoupling between the platter and record surface.**