Pressing problems for a record future

Sales of audio records are tumbling, and the manufacturers appear helpless to stop it. They blame cheap tape for their plight. The real reason is poor quality resulting from bad technology. But if the record companies seem to have problems now, wait until they try making digital discs

Adrian Hope

Today's record buying public does the job of an unpaid quality control department for most record companies. Even the most careful buyer of discs often has to make at least one return journey to his record shop to seek a better copy. The reason is that far too many records have blemishes, undetectable by eye, that make a mockery of high quality performances and hi-fi equipment.

Although the record industry stubbornly refuses to admit the fact, bad pressing of records is at the root of its present commercial problems. The topic of bad pressing is on the leading pages of each issue of many record magazines. Hi-fi enthusiasts believe that the hardware (the equipment) has far outstripped the software (the records) in quality but the record companies seem oblivious to a flood of criticism along these lines.

Sadly, the problem of bad pressing of records seems to be more acute in Britain than in Europe generally. But the industry across the world has nothing to be proud of. And although the good news is that things could be worse, the bad news is that they will probably become much worse before they get better, especially in Europe and the US.

The turning point for the record companies will be the arrival of digital discs. To make these, the sound is coded as a stream of millions of bits per second and recorded as a sequence of microscopically tiny pits. Digital discs will be in the order of 100 times more demanding to press than conventional discs.

The record companies prefer to blame the readily available and cheap blank tape cassette for their falling sales, despite strong evidence to the contrary from the habits of the record buying public. For instance, there is a booming trade in "direct cut" and "super cut" discs (analogous to "hand made") despite a price up to three times that of mass produced records. (A direct cut long-playing disc of Thelma Houston's music has sold more than a quarter of a million copies.)

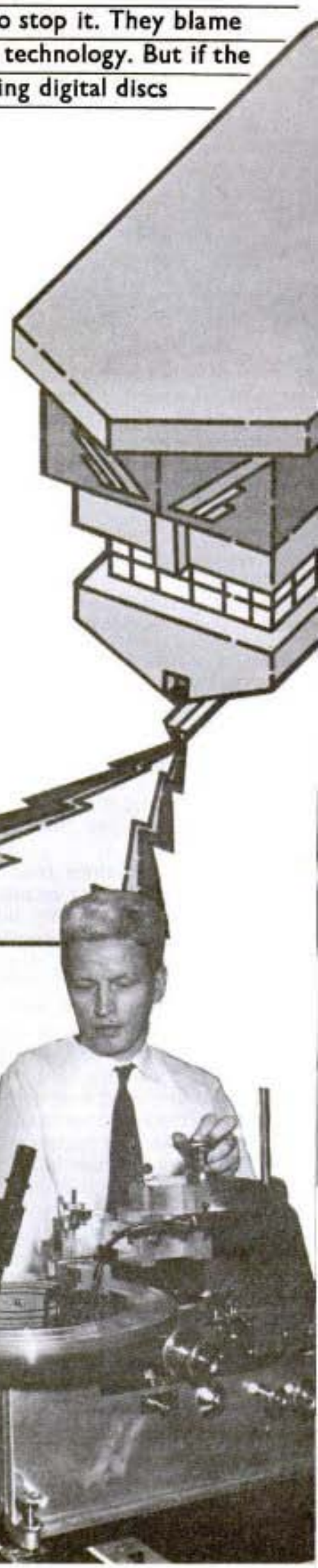
According to the record companies and their trade association, the British Phonographic Industry, sales have dropped because the public now economises by taping music from the radio or from discs borrowed from a friend or library, instead of buying discs. There is some truth in this. But the industry's practice of using the number of blank cassettes sold (around 30 or 40 million a year) to estimate the value of lost sales of discs (£150 million, or a third of the industry turn-over) is naive and fallacious. Every tape sold does *not* represent a forfeited disc sale. Much tape is used legitimately for recording speech, for promotions or for taping discs under licence.

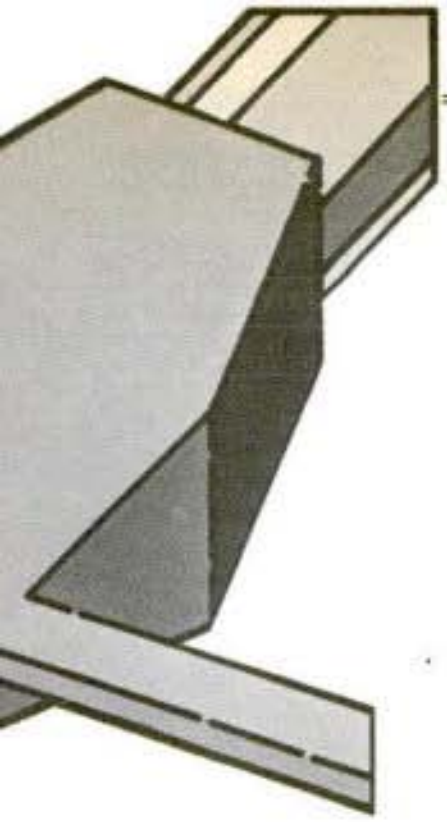
Many people use tapes to re-record selected items from their own discs, for use in cars or at parties and to save wear and tear on precious originals which are no longer available. And many LPs, especially of pop music, contain only one or two worthwhile tracks; by re-recording onto tape the purchaser can select the best items. A market research survey recently commissioned by the US Copyright Royalty Tribunal fired a broadside at the record industry's case. It showed that home taping is making a negligible impact on disc sales because those who make the most tape-recordings also buy the most discs.

Discs offer potentially better audio quality than tapes, better access to individual tracks and the large sleeve can contain much more information than a tiny cassette box. But if the pressing is faulty, all the advantages evaporate.

It is frequently argued that discs are still cheap by today's inflated cost-of-living standards. But most people have little spare cash now and many factories produce such poor pressings that the public will no longer buy discs as casually as they did a few years ago.

The record companies and the BPI have contributed to their own problems by seeking panaceas. For example, they have pursued the notion of adding a spoiler signal to recordings that is inaudible on the disc but is somehow magically capable of preventing any unauthorised taping; this has, at least temporarily, been recognised as a practical impossibility. But they have replaced it by plans for a levy on blank tape intended to discourage home taping and reward the record industry for its lost disc sales. The Department of Trade is

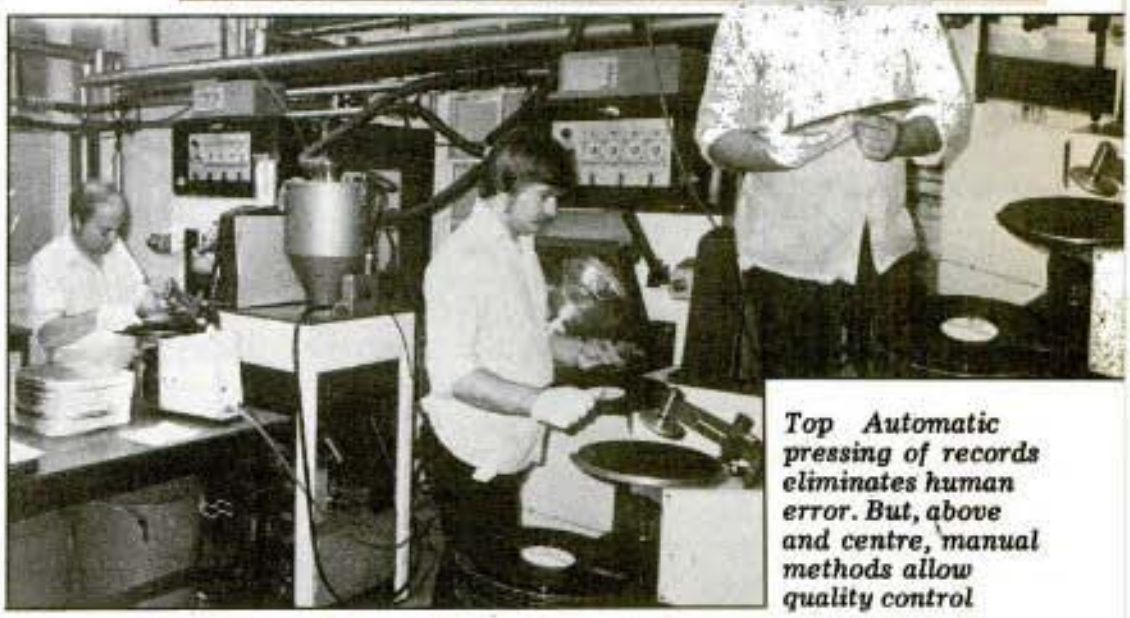




Bottom left Spring 1948: Peter Goldmark and Rene Snepvangers of CBS working with the original disc-cutting lathe used to develop the 33⅓ rpm microgroove LP

Right Comparative drawing showing the tracks of pits on a digital disc record, compared with a human hair and the groove of an LP record (all drawn to the same scale)

Adrian Hope



Top Automatic pressing of records eliminates human error. But, above and centre, manual methods allow quality control

said to be "sympathetic" and undenied leaks suggest that a very high levy, in the order of £4 or £5 a cassette, is hoped for.

The tape companies fear that the BPI intends to push the levy scheme as far as possible behind closed doors and are preparing a counter lobby for use if the proposal reaches parliament. In the case of EMI, which sells both discs and blank tapes, the dispute could prove highly embarrassing.

But in practice, the notion of any government being prepared to alienate many voters by taxing blank cassettes at several pounds each is bizarre. It becomes more so, when one considers that many cassettes are bought for legitimate use. And how could the levied tax be distributed to those artists who were entitled to it? Would low sales of a disc be taken as justification for high reward from the tax? The levy scheme is as hopeless as the spoiler signal. The record companies are losing the sympathy of the record buying public by even considering it. And they could have put their time and effort to better use by improving their record pressing technology.

The logic of doing this is backed up by the imminence of digital sound. This offers greatly improved reproduction quality—but at a price. The main advantage companies have claimed for the digital discs proposed so far is that they can be mass produced using pressing techniques and equipment similar to that used for pressing conventional discs. But the accuracy necessary for pressing digital discs is about 100 times higher than those for pressing conventional "microgroove" LPs. If the record industry cannot produce conventional LPs of consistent quality, it has no hope of coping with digital discs.

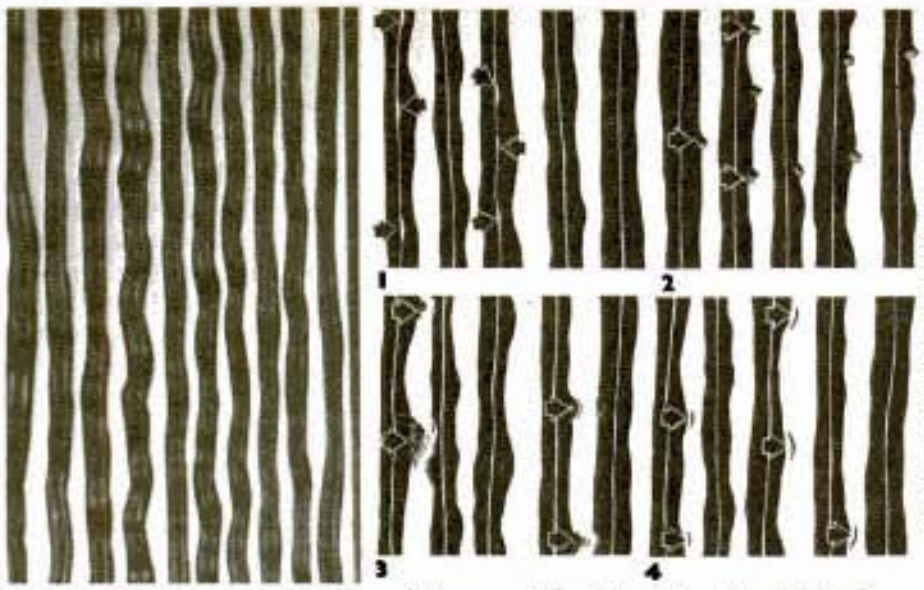
In a mono (single-channel) record the two walls of the groove have identical undulations and the stylus moves from side to side. The two walls of the groove undulate differently, one carrying left—and the other right—channel information and the stylus moves up and down as well as from side to side. If recorded sounds are out of phase in the two channels the vertical movement may be too extreme for the stylus to follow accurately. Thus, right from the origin of a recording in the studio, strict attention must be paid to "phasing" or the replay stylus may bounce (causing distortion), skip a groove or two or stick. And discs which are satisfactory on some equipment, will be unplayable on others.

The master tape from which the disc is made is played on a modified tape recorder which has two playback heads, one in front of the other. The advance head feeds a control circuit which computes the phase, frequency content and volume level of the programme. As the diamond cutting tool moves across the blank lacquer (jargon for an aluminium covered disc of cellulose plastic) to gouge out a modulated spiral groove, the pitch of the spiral is continually altered in sympathy with the computer-control signal arriving from the advanced head on the tape player. In this way the grooves on the disc surface can be packed as tightly together as possible for the particular sound. When the music is quiet and contains mainly high frequencies, the groove undulates slightly and can be packed closely together. When there is a loud bass passage, the undulations will be large and their spacing must be wide. If grooves come too close together the stylus may stick in a single groove when the record is played, which is annoying and could damage the stylus.

Close grooves also produce a phenomenon known as "pre-echo"; with this the listener hears in advance an "echo" of a sound in the next groove. If even a trace of pre-echo is introduced at the cutting stage, it is likely to

become progressively worse at each subsequent stage of the record making process.

But the computer must itself be controlled by the cutting engineer because if the grooves are cut too far apart there will be insufficient playing time and the record will offer poor value for money. An unskilled engineer may be tempted to play safe and reduce the volume and bass content of the sound artificially. But the final product will then sound anaemic. Moreover it will have to be played with the volume control turned well up and this will emphasise the presence of any unwanted background hiss or click from the disc. An automatic lathe that does this job has been developed by CBS in the US but is not being used on any scale. The depth of the groove also varies with the sound being recorded, but too shallow or too deep a groove will present problems in the pressing process.



Damage to LPs takes four common forms. **1** *The apex is irregular instead of straight because the stampers touched; it causes patchy background noise.* **2** *Pinprick holes are formed in the walls of the grooves when air is trapped in the mix; the effect is "snap, crackle and pop".* **3** *Large irregular holes in the groove walls cause "tearing sounds" over music.* **4** *Blemishes between the grooves cause intermittent noise. Far left A 200 magnification of stereo grooves shows damage caused by a worn stylus*

In all these matters the cutting engineer's problems are compounded because the master lacquer is never played to check for quality. Instead it must be electroplated as soon as possible after cutting.

Electroplating the lacquer is a unique craft. Every company has its pet approach and philosophy, albeit often tailor-made to suit available facilities. To give just one example, some factories pass the deionised water used in the electroplating baths through filters that catch all particles larger than one micrometre. But others argue that filtering to 20 micrometres is adequate. The master lacquer is meticulously washed, given a thin surface coating of silver to make it electrically conductive and plated with pure nickel. The lower the plating current and the slower the plating process, the more accurately the nickel will be deposited. But record companies are run to tight profit margins and engineers are put under pressure by the accountants to plate fast (taking three hours or less) at high current. The trade-off for increased profit is more background noise on the finished product and a subtle loss of high frequencies. This is because a fast plated nickel coating has a coarser finish and fails to follow the shortest wavelengths in the groove accurately. After plating, the metal master disc is carefully peeled away from the lacquer. The lacquer is now useless and if the metal master is in any way faulty a new lacquer must be cut from the master tape. Alternatively the faults must be tolerated in every disc pressed. The metal master is a negative replica of the master lacquer, so the record grooves stand proud from the surface as a pointed spiral. Anything but the most delicate handling of this metal master may blunt the pointed peaks and in the finished product this damage will be replicated as a groove with a blunt bottom instead of a sharp apex.

The crucial importance of an accurate relationship between stylus and bottom apex of the record groove is often overlooked. When a gramophone record is played with a correctly shaped diamond stylus, the stylus is supported by the walls of the groove and its tip never touches the bottom. If the stylus is damaged, allowing it to sit too low in the groove, or if the groove bottom is rounded rather than vee-shaped, the stylus tip will track the bottom of the groove. This will create an infuriating background noise. Moreover every gramophone record contains at least some dirt (accumulated either in the factory or in domestic use) which is trapped at the bottom of the groove. If the stylus tip touches this dirt there is more background noise.

The negative metal master is electro-plated to produce a positive "mother", which is a nickel replica of the original lacquer. This is the first stage of the production process at which the actual sound quality can be checked by playing a disc. It is also possible at this stage to repair some blemishes. Both EMI and Decca employ full time staff to identify any clicks on the mothers, locate the culprit blemishes under a microscope and—where possible—literally pick them away with a fine pointed probe. On average two or three blemishes are likely to be found and repaired on each mother. But some record companies do not have the equipment or experienced engineers to make repairs of this type.

The nickel mother is now electroplated to produce "pressing stampers" which are of negative form (the groove is again represented as a sharp pointed spiral ridge on the metal surface). Here the accountants again step into the picture by insisting that as many mothers and stampers as possible are "grown" by electroplating from each master, that they be grown as fast as possible, and that the stampers be used for as long as possible in the presses. On this point every factory manager adopts his own attitudes and compromises. The greatest differences are seen even within one factory, between metal work grown for pressing pop records and that for classical music. As a guide, although "stampers" can be grown in as little as 20 minutes each, an hour is the minimum for a classical disc. A factory churning out pop LPs, and anxious to produce as many discs from a single original lacquer as possible, will grow half a dozen mothers from the metal master and literally hundreds of stampers from each mother. This makes a total of a thousand or more stampers available before it is necessary to re-cut a fresh lacquer from the original master tape. But for classical music, or super-high-fidelity pressings, the number of mothers and stampers grown is considerably less. Teldec in Germany, arguably the best pressing plant in the world, may produce four mothers from a single master but keeps the number of stampers grown from each mother down to below 40, and often as few as 15 or 20. There is in fact no physical limit to the number of mothers and stampers that can be grown; but the sound quality of the final product falls off drastically as the number rises. Some records which sound distorted are perfectly well pressed but originate from worn metal work.

Similarly, the number of quality discs that can be pressed from each set of stampers (one for each side of the record) also varies widely. If the stampers are fitted clumsily into the press, or the pressing force is too great, or the stampers are allowed to crash against each other during the pressing operation, the delicate spiral ridge will be blunted and will start to press deformed grooves which sound noisy when played. If the stampers are lopsided in the press, then their wear may be uneven and the record noise will fluctuate. As few as a thousand discs may

be pressed from each stamper for a super hi-fi pressing, and around 3000 for other classical production runs. For pop, the sky's the limit.

It continually grieves the recording and cutting engineers, who devote considerable care and attention to producing a master tape and disc which offers the best sound possible, that it is usually a press operator with an untrained ear who decides when a set of stampers has worn out! The pressing process relies on loading a carefully gauged amount of vinyl mix into a mould and sandwiching it between the two stampers.

Arguments rage over the pros and cons of automated and manual press operation. In fact it is possible for an automatic or a manual press to produce either good or bad pressings. Teldec in Germany uses both types and produces equally good pressings from either. A manual press allows for quality control at the point of production, but is subject to human error. If set-up correctly, a fully automatic press will churn out top quality pressings, independent of operator fatigue. But an incorrectly set-up automatic press will churn out a run of consistently bad "faulties".

Arguments also rage over the amount and type of vinyl mix to be used in the press and the length of pressing cycle for each disc. In general the more vinyl used, and thus the thicker and heavier the pressing, the less likely it will be to warp in storage or use. A few years ago, when vinyl was still just a cheap oil by-product, most discs would weigh at least 160 grams. Since then the weight has dropped to an average of around 120 grams, but with some companies offering an extra 20 grams for classical records. The risk of warpage (both immediate and delayed) is increased if the presses are run fast and the hot pressed discs given little time to cool before handling and packing. To the delight of the accountants, some automatic presses can now run on a cycle time of as little as 20 seconds per disc. At the other extreme, a manual press may have a cycle time of as long as 40 seconds per disc. The happy medium is around 30 seconds on an automatic press.

Some companies (such as EMI) feed a dry powder mix of polyvinyl acetate and polyvinyl chloride to the press. This mix is heated to around 150°C by mechanical kneading just prior to injection into the press. Other companies, such as Decca and Teldec, feed the presses with hot chunks or "dice" of preformed PVC mix, which has been blasted with hot air just prior to use. But the trick in each case is in getting the molten plastic to flow smoothly across the spiral ridges of the stampers, leaving no air pockets which will cause pits in the pressed record.

A few companies (including Decca in England) argue that it is not only economical but also of benefit to the final audio performance of the disc if reject discs are reground and the vinyl used again. According to the Decca philosophy, the more the vinyl is recycled the smoother it becomes. But others, ironically including Decca's German sister company Teldec, reject the idea of recycling because it introduces a degree of unpredictability into the pressing process. At any given time there is no way of knowing how much of the mix is virgin and how much is recycled. Most companies, like EMI, simply compromise by using recycled vinyl to press pop records and virgin vinyl for classical music.

The modern microgroove LP has around one kilometre of groove on each side. This groove (like human hair) is about 50 micrometres wide and must resolve waveforms down to 0·025 micrometres in amplitude. In this aspect the LP record is probably the most precisely formed mass produced item moulded in plastic. It could therefore be argued that anyone buying a perfect LP is as lucky as a pools winner. But techniques developed over the past 30 years allow factories to produce long runs of perfect pressings. Companies' loss of pride in their products and the tendency to cut corners to make economies (false ones as it turns out) are to blame for the record industry's present poor performance.

All the video and digital audio disc systems so far proposed involve—in fact, boast of—the use of discs pressed from plastic. The Philips optical disc, with a reflective coating that is tracked by a laser, is immune to finger marks on the reflective surface. But its quality of audio and video reproduction relies entirely on the accuracy with which the information pits under the reflective surface have been pressed into the plastic. The capacitance and piezo-mechanical disc systems rely on similar precision. Very few record companies seem to fully appreciate the horrendous demands of precision which these new reproduction methods will place on their pressing plant and people.

In practice most digital discs will carry a spiral track of pits spaced apart by around 1·5 micrometres with individual pits each around 0·5 micrometres wide and a micrometre long. The individual tracks and pits are therefore one-hundredth the width of a conventional LP groove. It will prove impossible to produce such discs in conditions that exist in the conventional record pressing industry.

To produce digital discs successfully, companies will need plants that are cleaner than a hospital operating theatre, with the workers dressed in the equivalent space suits. The only factory so far built to produce Philips format video discs on a commercial scale is the MCA plant in California. No visitors have yet been allowed inside but it is widely believed that the failure rate of the MCA production line is over 90 per cent. Even the 10 per cent of discs now offered for sale are often faulty. This month Philips starts to install equipment in a factory in Blackburn, Lancs, for video and digital audio discs. Pilot production is expected later this year as a run-up to a joint Philips-Polygram commercial launch of the Compact Disc digital system in late 1982. So far there are no signs of any comparable activity by any other British-based record company. Some, like EMI and Decca, are in no financial state to make the heavy capital investment required. Others appear simply to be playing ostrich. But elsewhere in the world, particularly in Japan, plans for digital disc production are already well advanced.

Once a digital product of reliable quality is available, hi-fi enthusiasts will gladly stop buying conventional LPs. So any British record company which fails to improve its standard of pressing conventional LP discs or to make plans to press new technology digital discs, will follow our electronics companies to the wall. □

Oops! What one unlucky disc reviewer was sent