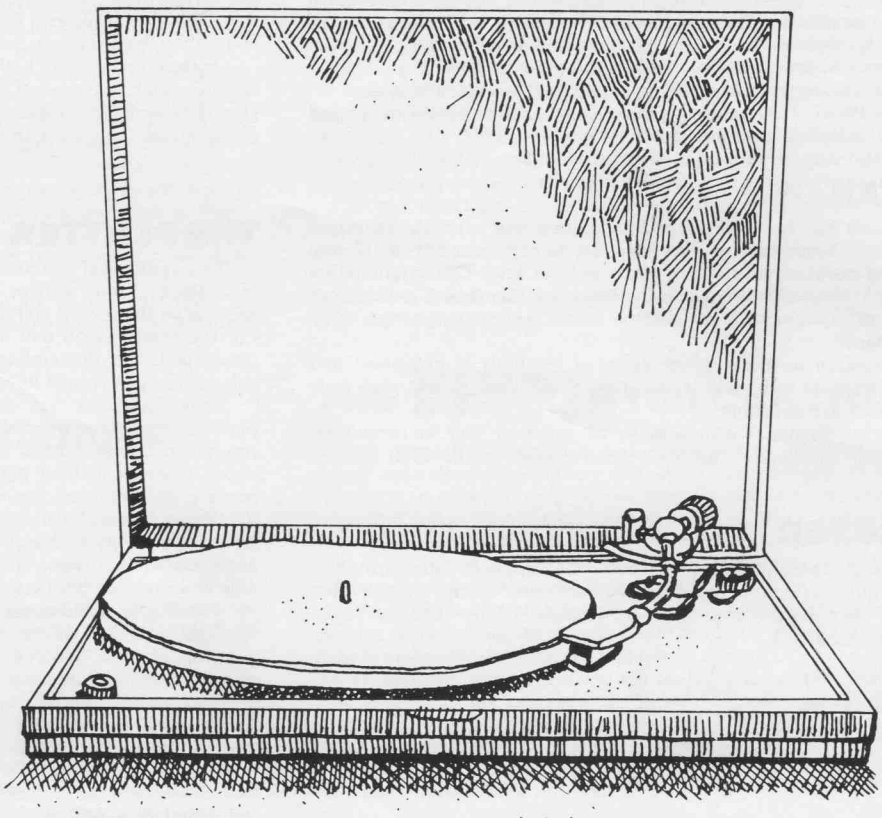

rega

rega SOUNDS BETTER!

INTRODUCING THE BEST LOOKING TURNTABLES YOU'VE EVER SET EARS ON!

Looking at a Rega turntable you will probably notice a distinct absence of the many gimmicks and gadgets which are currently being fitted to so many record decks. Concentrating much more on high quality, Rega has been able to keep the design simple and very effective.

At every design stage Rega has considered the effect on reproduced music and engineered the wow, flutter and rumble so that the ear is least annoyed. Thus they achieve far better music reporduction than a turntable designed only to perform well into test equipment.

For those with particular arm/cartridge interface problems both the Planar 2 and Planar 3 are available without tone arm.

The overall dimensions of the Rega turntables are 466 mm X 365 mm X 125 mm with the dust cover shut (17⅝"W X 14¼"D X 4⅞"H).

They are belt driven with two speeds, 33 rpm and 45 rpm, manual speed change and on/off switch.

THE PLANAR 2

The combination of a glass platter and hybrid mat is an integral part of the Planar 2's musicality' and isolation from mechanical and acoustic feedback.

The Planar 2 is fitted with the Rega tone arm, recognized as being one of the best and most versatile that is currently available. The arm is an excellent combination of low mass, high rigidity, lack of resonances and very low friction levels. Nearly all cartridges can be used including those with a very high compliance. Bias is achieved magnetically.

While maintaining very exacting standards of quality and sound reproduction the Planar 2 must surely be one of the most competitively priced turntables in the Hi-Fi Market.

THE PLANAR 3

The Planar 3 has been developed to extract the ultimate in sound quality from the Planar design. The turntable is engineered from 12 mm plate glass and covered with 3 mm thick natural felt. This combination helps stop high frequency vibration feedback to the record and assists the rest of your equipment to produce a stable stereo image and clear, unmuddled sound.

Careful attention to every minor detail of assembly is important and the designer personally checks every turntable. This means that only limited quantities are available.

Adjudging the Planar 3 with arm to be the best buy in turntables, The Audiogram considers it "probably second only to the Linn Sondek LP12."

DUST COVER

The thin and resonant nature of most lids supplied with turntables makes them quite effective receptors of air-borne energy. Rega uses acrylic rather than polystyrene or p.v.c. because of its superior rejection of acoustic feedback.

HINGES

The dust cover hinges are Rega's own design and could more properly be termed acoustic decouplers since they are designed to effect maximum resonance isolation between lid and plinth.

BASE

Thin sheet metal, plastic, aluminum, and/or wood box construction was rejected since the air so enclosed acted as a helmholtz resonator generating its own sound. Rega turntables use solid, one-inch-thick low resonance particle board stressed with a solid hard laminate. The result is a hard and light plinth with exceptional isolation from acoustic feedback.

FEET

Conventional use of four feet means that unless the turntable is precisely stable the unit will rock minutely in response to feedback. Since it is impossible to rock a tripod, Rega uses three feet (this also allows ease of leveling) each consisting of three layers of rubber possessing different resonance frequencies for maximum isolation.

THE MOTOR

The motor is a 24 pole synchronous type revolving on a mirror finished bearing shaft running in large self-lubricating bronze bearings and is controlled by a phasing capacitor specially selected for a low level of vibration. The motor is dynamically suspended on nitrile rubber mountings uniquely designed to give 3 different vibration isolating frequencies. Because of low turntable bearing friction the motor revolves at almost half power, further reducing its noise and vibration output.

THE DRIVE SYSTEM

The drive system consists of an injection moulded plastic pulley and hub coupled by a round section rubber belt. The use of relatively inert materials in the coupling system effectively isolates the metal motor and turntable spindle and eliminates the transmission of metallic resonances from these parts to the stylus.

THE BEARING AND SPINDLE

Conventional practice is to utilize a resilient thrust pad to decouple the platter shaft from the plinth in an attempt to isolate resonances. This can be quite effective although Rega Research found that it also decouples the stylus from the record groove and deteriorates bass reproduction. Rega therefore utilizes a unique steel ball thrust pad for a direct coupling and tighter bass reproduction.

On the thrust pad in a bath of thick high pressure oil is a 5/16 inch diameter spindle which is precision pressed in the hub and revolves in a diamond lapped bearing that retains a lubricating film between bearing and shaft giving an 'oil' bearing with no lateral metal contact.

THE PLATTER MAT

The traditional practice of using metal platters necessitates the use of a thick "lossy" rubber mat usually containing ribbed circular rings to suspend the record and damp out the metallic resonances of the platter. For the same reason that it is undesirable to use a resilient main bearing thrust pad, this decoupling of the stylus from the record by the thick soft rubber pad results in loss of bass detail and tightness.

Rega Research has developed the technology for manufacturing plate glass platters which have very different and more easily controlled resonance characteristics than metal. An added benefit is that the precision inherent in float glass can only be achieved in metal through expensive precision machining. To damp out what resonance does exist, the Planar 2 uses a thin hybrid mat which preserves bass tightness and avoids the small resonant cavities formed when a record is played on a circular-ribbed mat. These cavities resonate in response to the resonances generated by the stylus as it traverses the record.

The Planar 3 utilizes a 3 mm thick felt pad which more ideally suits its slightly thicker (12mm, 4½ lb.) platter and allows tag cuing. The combination of glass and felt helps stop high frequency vibration feedback to the record and allows for the production of a stable stereo image and clear, unmuddled sound.

Rega turntables do not have electronic speed control since this invariably degrades the audible performance. Rega uses a synchronous motor which locks on to the mains frequency and hence cannot be less accurate than electronic speed control that uses as its reference a neon light illuminated at a rate determined by the mains frequency. Speed control via a neon light can therefore be no more accurate than the tolerance of the supply voltage which is itself inaudible.

Furthermore, speed control usually exists primarily to correct drift which is itself the result of the electronic parts warming or aging. To overcome this irony manufacturers are introducing feedback systems based on references independent of the mains supply i.e. quartz crystals. The quartz crystal produces a reference which is compared to the revolving platter. An error signal is produced which indicates the amount of correction required.

This type of speed adjustment, however, is still capable only of correcting relatively slow speed drift and is wholly inadequate when dealing with the audibly offensive high frequency flutter caused by the momentary slowing of the platter as the stylus encounters a high frequency transient. Turntables utilizing feedback error for speed adjustment will inevitably further degrade the performance when encountering these

flutter-producing transients. This is because speed correction does not take place until after the transient information is traversed by the stylus and an error signal derived. Speed correction takes place after it is no longer required and therefore creates its own error which requires subsequent correction. This constant modifying of the signal exacerbates the annoying high frequency flutter which the system was supposed to correct. In addition, the sophisticated electronics required for this self-defeating exercise are less reliable and more subject to aging than the rest of the turntable. The circuit boards themselves are also the source of unwanted resonances in many electronic units.

DIRECT DRIVE

It is not necessary to engage in the best drive vs. direct drive controversy in order to make a very bold statement: **Rega turntables are superior in their audible performance to any direct drive in, or remotely approaching, their price range.** This is not due to any inherent superiority in belt drive design but rather that the predominant research focus on direct drive and sophisticated speed correction has been at the expense of other more audibly important areas. Rega Research recognized this situation and designed a complete acoustic system based on its ability to reproduce music accurately in the manner most subjectively satisfying and fatigue-free to the listener. It is the achievement of this design goal which gives Rega turntables their sonic superiority.

SPECIFICATIONS

Manufacturers provide quantitative measurements of turntable performance in the naive belief that this information will aid the consumer in making an intelligent, rational and audibly satisfying choice among a myriad of competing products. What turntable manufacturers neglect to state is that the wow, flutter and rumble specifications they provide bear little or no relationship to the 'sound' of a turntable. No one understands, in quantitative terms, the relationship between traditional parameters of turntable performance and the subjective enjoyment of music reproduced on a turntable. This is because the ear is capable of resolving subtle nuances in musical reproduction which defy measurement. The result is that many turntables on the market today are designed to produce impressive statistics but are incapable of reproducing music with a high degree of accuracy and a minimum of subjective annoyance. Rega turntables are the antithesis of this design approach and all engineering trade-offs are entirely related to their effect on perceived audible performance.

On Rega turntables wow, flutter and rumble are so low that there is presently no known method of accurately measuring them or of relating these measurements to sonic performance.

LIMITATIONS OF SPECIFICATIONS

WOW AND FLUTTER

Wow is slow speed variation usually of 10 Hz or less and flutter is higher speed variation usually measured at a single frequency around 3kHz with a sine wave record. Of the two, wow is easier to measure and, as touching the edge of a turntable or playing an off-center record will demonstrate, audible wow is very annoying. The point however is that wow is only annoying if it is very obvious—usually 0.2% to 0.3% (a figure up to 10 times that usually claimed for modern turntables). The ear is therefore relatively insensitive to moderate amounts of wow.

Flutter presents quite another problem because the ear is more sensitive to its presence, so sensitive in fact that it can discern flutter components which defy measurement. In addition, higher frequency flutter components are more annoying to the ear than are those of lower frequency. In an attempt to measure these minute quantities, increasingly sophisticated test equipment is introduced. The sensitivity of the test equipment required is such that it is susceptible to electrical mains interference, seismic vibration and surface noise on the test record. In attempting to separate the wow from the flutter component or the lower frequency flutter from higher frequency flutter, additional sensitive test equipment must be introduced which in turn compounds the overall inaccuracy of the measurment.

The paradox of course is that to obtain a figure with any pretense of accuracy, the wow and flutter components are lumped together thus rendering the specification all but meaningless. Because of the differing sensitivities of the ear to wow and flutter, a turntable with an impressive overall specification containing a high flutter component will sound worse than one with a poorer overall specification but which contains a lower flutter component. This is but one contributing factor to the specs well, sounds terrible syndrome so common in high fidelity today.

RUMBLE

Rumble is unwanted low frequency noise generated by the main bearing and the motor and includes the hum field from the A.C. motor or the D.C. transformer. For the following reasons conventional rumble tests are completely useless for the purpose of comparative sonic assessment of turntables. Given the impossibility of producing a rumble-free record, rumble tests must be made with a test record which itself contains rumble. Furthermore, the rumble component of a turntable may be cyclic (33-1/3 r.p.m. and harmonic multiples thereof) or random in nature. The rumble component contributed by the hum field will also vary as the cartridge traverses the disc and moves in relation to the hum field source. A cartridge must be used which is itself non-linear and the rumble figure will fluctuate in response to turntable-arm-cartridge interface related variables.

If turntable rumble is exactly in phase with the rumble on the test record the final result will be exaggerated while if it is out of phase cancellation will occur and an impressive specification will result. Under test conditions there will likely be some degree of phase difference so that any number of frequency components will result. Under dynamic music conditions the result of these successive cancellations and additions will be that musical information will be removed, exaggerated or distorted.

The use of weighted rumble measurements also further obscures the relevance of this specification by ignoring subsonic rumble. Subsonic rumble may excite arm—cartridge resonances, cause mistracking, suck out the power amplifier power supply in an effort to reproduce this rumble, and result in large excursions of the speaker cone which cause considerable IM distortion.

WHY REGA TURNTABLES SOUND BETTER!

Recognizing the limitations of conventional specifications was a liberating experience at Rega Research for it allowed them to concentrate on previously neglected or unknown parameters which do affect sound reproduction but do not lend themselves to quantifiable measurement.

Research revealed that the most important neglected parameter was the distortion caused by acoustic feedback at all gain levels and all frequencies. The taming of this feedback information is in turn intimately related to an understanding and control of resonances generated by the stylus and motor and excited in all parts of the turntable by feedback information.

In the development of Rega turntables conventional specifications were used only as a guide, and the choice of turntable design philosophy as well as the selection of individual components was made entirely on on the basis of their contribution to audible performance. **The Rega turntable is therefore a synergism: the overall sonic achievement is greater than the sum of its parts.**

THE rega R100 CARTRIDGE

The Rega R100 cartridge was developed to afford the listener more emotional enjoyment than any cartridge in and beyond its price category. Rather than concentrating on one specific aspect (trackability, frequency response, stylus shape, etc.), all too often at the expense of the overall performance, Rega designed the R100 cartridge to retrieve musical information with a dynamic realism yet full-bodied smoothness typically found only among more expensive moving coils.

The R100 is exceedingly versatile and will perform admirably in inexpensive record changers as well. Often the R100 will prove the simplest and least costly method to upgrade a playback system.

To evaluate what the Rega will do for your system, have your dealer play your cartridge and then the Rega. Just ask yourself which cartridge sounds more emotionally satisfying. After all, the purpose of any hi-fi equipment should be to maximize the excitement and pleasure of reproduced music. We think you'll agree that the Rega R100 succeeds commendably in achieving this goal.

SPECIFICATIONS

Weight:	6.2 grams
Frequency Response:	From 1Hz to 20kHz plus, limits dependent upon amplifier input stage and velocity, acceleration, and wave form of applied frequency
Output Voltage:	4.5mV at 5 cm/sec
Stylus Shape:	Super hypo catino elliptoid
Compliance:	Static compliance circa 25 cu
Vertical Tracking Force:	1.5 g — 2.0g (optimal 1.75g)
Recommended Capacitance:	300—350 pf at phono input stage

The aim of the game

The sound reproduction industry must be the only one whose products are designed to do anything but their original purpose.

Consumer products are usually designed to try to do the job for which they are intended, eg a vacuum cleaner is developed to try to pick up dust, a washing machine is engineered to try to clean clothes, a chair is designed to be sat in, a boat is built to float, etc. Following the same approach, hi-fi equipment should presumably be designed to reproduce music. Nothing could be further from the truth! To explain this statement we will take each stage in the record production chain and analyse the design.

Turntables are carefully developed to play a constant tone of 3150 Hz into an expensive wow and flutter test meter, and produce a low noise level into specially conceived rumble test equipment. Another design aim is that they should reach a rotational speed of 33.3 rpm in less than one second (no doubt to appeal to dragster fanatics). Having reached full speed, a lot of development has gone into methods of showing that the correct speed has been reached. Stroboscopes are the most common method, and more recently, expensive digital readout systems tell you immediately if the record is 0.1% fast or slow. Ironically, having achieved correct speed information, turntable designers have also included methods of altering the speed so that it can become incorrect — presumably to enable the user to check that the stroboscope or digital readout is working correctly.

One manufacturer claimed that they manufacture 'The best Pick-up Arm in the World'. Certainly in the past they were the most internationally accepted tone arm manufacturer, but their main claim to fame seems to be that around half the cost of the arm is spent on a superb finish that tries to make the arm look like an expensive camera. Recently a new arm has been produced which also claims to be 'The best Pick-up Arm in the World'. So we now have two entirely independent arm manufacturers both claiming to be the best! The interesting point is that each sounds completely different when fitted with any cartridge, and their designs differ entirely. In fact, the only similarity is that both arms screw into the same awkwardly shaped mounting hole. So we can infer that to make 'the best' arm one has only to design it to fit this esoterically shaped hole.

Cartridges tend to be designed to try to produce a straight line graph when played into an expensive pen recording machine. If you can pay a bit more money, a graph can sometimes be bought with the cartridge (presumably the purchaser believes that his eyes can tell what the cartridge will sound like). As the cost increases, more design time is spent on elaborate packaging. It is often heartbreaking to have to remove your cartridge from its polished, grained wood box and screw it into a tatty old headshell. We even came across one firm that were considering a package that cost more to produce than the cartridge.

All heart

The amplifier is the heart of the record production chain. Very simply, they are often designed to encompass as many knobs and switches as possible. Electronic boffins spend years thinking up completely useless functions so that an extra switch may be fitted to cancel something that doesn't exist. For many years I owned a receiver fitted with seventeen buttons of which I used three, and five knobs, of which I used two!

Having decided the quantity of chrome appendages, the design team considers the electronics that will connect to the switches and designs it to produce sine waves and square waves into a resistor. In my early naïve hi-fi days, I assumed that 8 ohms was the best make of loudspeaker because all amplifier manufacturers quoted their specifications when connected to it. In fact, the parameters governing amplifier design are bewildering and it must cause considerable problems to include all of them. One of the most ingenious is a device to help you save electricity. It works by emitting a loud crack through the loudspeakers whenever anyone switches on a light, the fridge or any other electrical apparatus. The crack usually comes at a crucial part of a piece of music and is designed to annoy the listener intensely, thus preventing the use of superfluous domestic equipment like heating, lighting and refrigerators.

The final point in the musical reproduction chain is the loudspeaker. The 'best' loudspeakers are simply designed to remove all the nasty noises that the rest of the equipment has introduced. Unfortunately, along with the noises that the rest of the equipment has introduced, any last vestige of music that may have accidentally found its way through the previous obstacle course is also removed.

There seems to be continuous competition to produce a loudspeaker with more crossover components and more speaker units. We have even found loudspeakers with completely superfluous crossover components so that the manufacturer can quote a higher quantity in his advertising material and hope that he impresses reviewers. There are also loudspeakers fitted with additional high frequency tweeters which cause a degredation in sound quality. However, the manufacturers find them easier to sell with four speaker units than with three or two.

The result

The end result of our marvellous modern hi-fi design is sometimes a music reproduction system that produces less music than many radiograms of thirty years ago.

The reader may feel that the previous paragraphs are a little flippant, satirical, sarcastic or even exaggerated. However, beneath the farce, the facts are substantially correct and I am trying to make a serious observation by appealing to designers to consider the reproduction of music. Now most 'hi-fi' equipment designers, old or young, arrogantly think that they understand all or most of the technical parameters governing the design of their creations. There are incessant, unending arguments governing the relative merits of cascode input stages, field effect transistors, quartz-locked direct drive motors and air-cored inductors. In their certainty that the latest idea is the total answer to decreasing intermodulation distortions or reducing rumble, the designers seem totally unaware that no-one — repeat *no-one*, understands even one thousandth of the reasons for human beings enjoying emotional pleasure from listening to music (that word again!). We should realise that the day someone understands all, and achieves a total knowledge of music reproduction, his company can produce the ultimate equipment and all other manufacturers will have to give up and join the civil service. It is the fact that we will never understand and achieve perfection that makes hi-fi fun and a constant source of learning and pleasure.

When we talk about music reproduction and its design, we are ultimately considering the human brain. It is the brain, via the ear, which receives and distinguishes the complex vibration signals which constitute music. No-one can explain how the brain works, why we enjoy music (or dislike some of it) or even what constitutes enjoyment. Of course a few eminent neuro-surgeons have a few theories on the basic technicalities of the brain, but they would probably be the first to admit that our current extent of knowledge only shows us how little we understand. The more we learn, the more we realise the extent of our ignorance.

In any science, a new discovery only helps to enlarge the realm of the unexplained and to impress on us the limited extent of our comprehension.

If only hi-fi designers were humble enough to accept the same philosophy and realise that our achievements are only a miniscule part of what utlimately could be possible.

It needs an understanding of our lack of knowledge to generate any real worthwhile achievements.

To sum up the last few comments, the dogmatic designer who believes that he totally

understands his design, will progress no further as he is limited by his total understanding of the accepted parameters. However, if we accept that we understand virtually nothing, but we use our pittance of scientific knowledge with intuitive and artistic flair, then we may progress a little further in our quest for musical enjoyment.

All sciences through the ages, have been restricted by the narrow-minded dogmatists who create fixed and inflexible parameters. In hi-fi we have the unfortunate purveyors of specifications such as wow, flutter, rumble, pivot friction, effective mass compliance, frequency response, RMS power output, harmonic distortion, intermodulation distortion, etc, all of which are *totally and completely meaningless* in the context of musical enjoyment, and entirely misleading to the hi-fi buying public.

The greatest scientists of the past have always been characterised by their artistic flair and an extrovert arrogance that has forced them to question accepted principles in their constant search for improvement. Unfortunately, any improvements or new ideas usually threaten the establishment and therefore there is always a fight to establish new principles.

The new ideal that a few small British companies are advocating is that hi-fi equipment should be designed to produce music and therefore designers should spend a lot of time in listening to their product. This necessitates designers that really enjoy music and those who achieve great emotional pleasure when listening.

This brings us in a full circle back to our ignorance of emotional pleasure and the establishment and cynics will correctly point out that it is difficult to quantify emotion and so how can a design be created purely subjectively? I would answer this as follows: It has now been proved beyond all doubt that the currently used technical specifications have no relevance whatsoever to the 'sound' of the equipment or its ability to reproduce music. Therefore, we can definitely say that the use of these specifications should completely stop in advertising and reviewing, and we can now assume that any manufacturer or reviewer that quotes these specifications to the public is completely ignorant of his subject. This leaves us with subjective design and reviewing as the only option. Whatever the opinion, it cannot be worse than the current methods of designing to a technical specification, and at best, we might start to see a few more achievements in our audio industry.

Misleading

Of course technical measurements should not cease, and designers should be constantly experimenting to try to find measurements that relate to their own subjective experiences. However, it will probably always be misleading to quote technical specifications to the layman as they can only represent a minute part of the design and will not be relevant out of context.

It is interesting that one or two reviewers have started to use subjective analysis to judge the quality of hi-fi products. It was initially thought that they would achieve nothing and that the various subjective judges would probably all have differing opinions. However, it has been shown in this magazine and others that a correctly organised subjective test can achieve a substantial degree of agreement among the listeners. It is my opinion that, to stage meaningful subjective tests, we must forget hi-fi and realise that musical pleasure is purely emotional. *We must completely eliminate tests that try to compare one sound with another.* (Incidentally, good hi-fi dealers should get rid of their comparators.) Reviewers, judges and panel listeners should then try to train themselves to quantify their emotional feelings when listening to music they enjoy. The greater the emotion, the better the product. We may then start to learn that greater emotion is received from equipment which produces a higher quantity of musical detail without adding synthetic sound.

After all, the difference between music and unpleasant noise can be only fine immeasurable detail. No-one can technically measure the difference between the sound of Barbara Streisand's voice and that of Joan Armatrading. However, the differences are totally obvious to any listener and consist of inflections, accents, nuances and indescribable details. It is these minute but definite characteristics that make the voices interesting or uninteresting, depending on taste. Likewise, all violins sound different, but if the differences were technically quantifiable, then we could churn out Stradivariuses (or is it Stradivarii?) on a production line.

Designers should try to produce equipment that reproduces these subtle differences rather than masking them. Perhaps product reviewers should only be people who are interested in the difference between the sound of an original Martin guitar and a Japanese copy. Finally, the hi-fi buying public (of which some are music lovers) should force themselves to stop being confused by slick sales comparisons between one set of speakers and another. Their only hope is to patronise equipment dealers that will allow them to listen to their intended complete system for an hour or more and then to decide if they enjoy the music.

Cartridge Special

Rega R100

This cartridge has gained something of a reputation since its introduction several months back and is made in Japan for Rega to their specification. The body is a solid looking job and has sensibly firm enclosed fixing lugs that can be used to obtain a fine fixing between headshell and cartridge. The stylus is removable and hence replaceable.

Rega are the manufacturers of the famous Planar 2 and 3 turntables which have built up an enviable reputation as two of the best lower priced turntables around although they are not usually available from your local radio store. They are built by a manufacturer who actively shuns reviews of any description and doesn't want a demand created that the production schedules can't meet. Hence the long waiting lists of a few months ago. The cartridge is in a similar position though the grapevine had informed us that this was an excellent product and at the £38 asking price a veritable steal.

The R100 is at home in the Rega arm (naturally) and turned in a performance that in value for money terms made several other models in this review seem hopelessly expensive for the performance offered. In comparison to the ADC for instance the Rega has a slightly dull tonal balance but with very good high end detail and resolution. Cymbals have that beautiful metallic sheen that so many cartridges fail to capture with a transient capability that was as good as any of the other magnetics. Yet with more control than the Shure which had all the attack but lost out on character or inner detail, the kind of thing that enables you to readily differentiate between types of cymbals, their position on the kit and if they are being struck hard or extremely hard.

The midband has a striking immediacy and is much fuller than the Shure or the ADC. A firmly struck piano rings and reverberates through its wooden body, a twelve string guitar rattles and jangles while a six string acoustic has plectrum noise, fingerboard noise and all kinds of small things that with careful listening can highlight the difference between cartridges. It all comes down to that intangible reality of reproduction coupled with an assured performance that inspires confidence throughout its general control and smoothness.

Stereo imagery was wider than with the ADC ZLM Improved and almost on a par with that of the Stanton which was exceptional in this respect. There was convincing depth although I did detect some compression on very complex passages, but the R100 was never in danger of letting go at all. I particularly liked the way it coped with some of my older records, particularly some of my midfifties jazz discs with—it has to be said—less than perfect surfaces. The R100 never seemed to enhance cracks and pops but rather to smooth them out and prevent them from intruding on the music too much. When I tried the Shure out on these records results were worse as this cartridge seemed to enhance them in comparison to the Rega. Truly an excellent cartridge then and at £38—enough said.

Conclusions

Taking the magnetics first the clearly outstanding model here was the Rega R100 which possessed a clean, tight, very dynamic sound with a fine tracking performance at under £40. This makes it a real bargain with broad application in many types of system from the mid-price up to the high quality—where it will certainly not disgrace itself perhaps until something a little more esoteric could be afforded. A system with a Linn/Rega R200/Rega R100 combination at the front end is going to be a very good system indeed.

In a way it is unfortunate that the Rega is so good and so cheap because it tends to make the others seem expensive. The Dynavector does not seem to have an awful lot more going for it than the Rega R100 and is considerably more expensive.

Turntable sounds

the debate continues

ROY GANDY of *Rega Research* is perhaps one of the UK's most progressive turntable designers and manufacturers. We recently spent a day with him listening to the differences between turntables, arms and turntable mats (yes, even mats can influence the sound).

Here Roy Gandy puts forward his theories about factors which influence the subjective performance of turntables.

IN February's edition of *Practical Hi-Fi & Audio,* during a system review containing the Rega Planar turntable, Fred Jubb (the reviewer) had asked us at Rega Research to comment on the following sentence which appears in our technical specification — *Please note that on the Rega Planar turntable wow and flutter and rumble are so low that there is no current method capable of accurately measuring them!* We then quoted sample figures for those that must have them.

Before going any further we would like to state quite categorically that this statement is completely true, does not in any way mislead and applies to *all* high-quality turntables.

Unfortunately, the general trend in high-fidelity advertising, marketing and reviewing has been to 'use' technical specifications to demonstrate quality. This has led to an overwhelming misuse of most specifications, in many cases even to the extent of gross misrepresentation.

About ten years ago we had a similar situation in the motor car industry when horsepower figures were quoted in many questionable ways. In these circumstances, reputable companies such as Rolls-Royce refrained from quoting performance measurements and used words like *'sufficient'*. The recent outcome has been that many organizations including The British Standards Institution and DIN have laid down compulsory standards for horsepower quotations, and now their general abuse has virtually ceased.

However the current position in the hi-fi field is far worse than ever existed in the motor trade. No one yet understands which specifications are indicative of audible quality, and no person or instrument is even remotely capable of measuring a multitude of phenomena which the human ear can detect. In the circumstances, the marketing media have latched on to any specifications and used them to sell their products.

At Rega Research we manufacture record player turntables and our section of the industry has latched on to the following specifications — wow and flutter; and rumble.

In this article, we will try to explain why these specifications are completely misleading (reviewers please stop using them!) and then give a small insight into the many complicated parameters that *do* affect turntable quality.

A definition of 'wow' is — slow speed variations of the turntable (the audible effect can be demonstrated by gently touching the outer rim of a turntable while a record is playing). A definition of 'flutter' is — very fast speed variations of the turntable. A definition of 'rumble' is — general unwanted low frequency noise produced by the turntable.

Wow and flutter

The wow or flutter speed variation is measured as a percentage of the actual turntable speed (at 33⅓ rpm). The measurements are always inaccurate for the following reasons: a — the specification is usually quoted as a combined figure although wow has a totally different effect on the sound quality of music than flutter; b — test equipment has to be extremely sensitive in order to try to measure the minute levels obtained with some modern turntables. Unfortunately this sensitivity can also pick up electrical mains interference, seismic vibrations and surface noise on the test record; c — any attempt to differentiate between wow and flutter frequencies involves the connection and use of further test equipment with extra inaccuracies and is itself a contentious subject.

At Rega we check the wow and flutter on every turntable we produce. This is a good production check to indicate that everything is working correctly. However, if we check during the evening, when mains interference and ground vibrations are lower, our measurements are around half the daytime level! Of course, these effects can be reduced by using sophisticated stabilised mains supplies and specially-made concrete test benches — but reviewers seldom use these facilities.

Rumble

Rumble (and all noise) is measured with a peculiar unit called the decibel (dB). The decibel measurement scale is logarithmic to facilitate expressing the enormous ratio of loudness detectable by the human ear (about one million to one). This means that a measured increase in rumble of only 3dB represents a forty per cent* increase in sound level when heard through a loudspeaker. Even a 1dB change is large (about twelve per cent) and can be very audible. The problem here is that rumble measuring equipment is usually only accurate to within plus or minus 1dB and there can be more than 1dB variation on different test records. Thus the total inaccuracy from one rumble test to another can easily be 3dB and if we add changes due to the skill of different test engineers the total could possibly be an inaccuracy of over 4dB.

Now, this inaccuracy is greater than the actual difference among the rumble levels on most good turntables. So the point we are making is that rumble measurements depend entirely on the measuring equipment and the final result has no relevance whatsoever to the audible effect.

Wow and flutter and rumble test equipment is only suitable for manufacturers to make comparative tests under carefully controlled conditions. They should not be used experimentally by review engineers to obtain specifications which are published with a view to turntable comparison.

Having pointed out that test result variations can be greater than the difference between one turntable and another, we have laid ourselves open to a possible flood of highly technical letters explaining new and highly accurate equipment and measuring techniques. Therefore, it is more important for us to mention that even if all test equipment were 100 per cent accurate and produced the same measurements regard less of conditions, then this data would still be misleading and have no relevance to the sound produced by the turntable.

To explain this statement we will offer a description of the nature of wow, flutter and rumble and their effect on reproduced music. Imagine two top-quality turntables. The first is a good belt-drive unit with a measured wow and flutter figure of 0.1 per cent. The chances are that 0.098 per cent of this figure is wow and 0.002 per cent is flutter. The second turntable has a measured wow and flutter figure of 0.05 per cent (under the same test conditions). However this much better figure may contain 0.04 per cent wow and 0.01 per cent flutter.

Although the first turntable has twice the combined level of wow and flutter and a much higher level of wow, the second turntable has five times the level of flutter and will almost definitely produce a worse sound when playing a record.

Very little is known of the subtle audible effects of wow and flutter because it is impossible to measure very low levels of flutter. Also it is always difficult to carry out experiments which measure subjective effects on the human ear (partly because every ear is different). However, current research is showing that wow is only annoying when it is obvious (usually at about 0.2 per cent to 0.3 per cent, depending on the music). Any wow below audible levels does not affect the music quality. On the other hand, flutter seems to have a considerable effect on the quality of stereo music reproduction even though it is so low as to be completely unmeasurable.

Rumble, as previously stated, is low frequency unwanted noise. It is mainly caused by the turntable main bearing and motor vibrations. Hum field from the motor is usually included in the measurement as well. Now, these unwanted noises are produced at all sorts of frequencies from below 1Hz to above 500Hz. Some turntables have most of their rumble at 50Hz, some at 200Hz and others have a random spread of different levels at varying frequencies. A few reviewers are starting to include oscillograms showing the rumble component at different frequencies. These make very pretty pictures but the audible effect of these different levels is extremely complicated and totally impossible to measure. The audible effect is also altered by the tone arm, the cartridge, the amplifier, the loudspeakers, the listening room, the shelf where the record player is placed and the position of the equipment and listener in the room.

Rumble affects the dynamic range of the music, it can be psychologically annoying, it can overload an amplifier input and cause distortion, it can increase low-frequency acoustic feedback, it can excite arm/cartridge resonances, it can cause excessive loudspeaker movement and resulting distortion and an important effect that is not generally appreciated is that it can partially cancel or alter bass output from the music.

Having discussed the ubiquitous wow, flutter and rumble we should point out that there is a fourth parameter that is just as important but seldom mentioned. This is distortion caused by feedback. Not just the low-frequency feedback that most hi-fi listeners have experienced, but minor acoustic feedback at all frequencies.

Even at low listening volumes, various parts of the record player and tone arm may pick up and resonate with airborne vibrations from the reproduced music. If this effect is added to the slight colorations caused by resonances that are present in all tone arms, the total distortion can be considerable.

On most record players, if the rubber mat is removed the turntable rings like a bell when struck with a hard object. This 'bell' acts as a very effective collector of the airborne music vibrations. Most bases or plinths are made from very thin sheet steel, plastic, aluminium and/or wood. The end result is like a sound box on a musical instrument such as a guitar or violin. This 'sound box' is also ideal for collecting and amplifying transmitted vibrations. The effect can easily be demonstrated as follows — obtain a string musical instrument and whilst playing a record at high volume, hold the sound box of the instrument to your ear. You will hear the instrument picking up various parts of the music. Remember that your record player is probably doing this and the vibrations that are collected are re-reproduced, causing distortion.

An experiment can be carried out on any turntable to determine the actual audible effect of feedback distortion — use a high quality, studio-type tape recorder and tape a record whilst listening through the loudspeakers at high volume. Then, without altering anything, make an identical second recording with the loudspeakers switched off. Obviously no acoustic feedback will be present in the second case and the two recordings can be compared *(viz. our turntable comparison in the May issue. - Ed.)*

All these audible effects of wow and flutter, rumble and feedback will cause turntables to actually alter the character of the music that is being played. This may be an overwhelmingly obvious change or an extremely subtle one. (If anyone doubts this statement we suggest they try using a top quality pickup arm and cartridge with a cheap autochanger turntable and then compare the sound with the same arm and cartridge used with a high-quality turntable).

The sound quality changes produced by different turntables vary considerably from the alterations that result from changing amplifiers, cartridges or loudspeakers. Those used to listening for the 'hi-fi' are quite often completely unaware of any change when listening to an A B comparison between two turntables. However, the differences can be quite drastic and when noticed become obvious.

A good turntable will keep life, emotion, clarity, ambience and a clear image in the reproduced music. This may not be noticed, but often, when one changes to an inferior turntable, no actual difference is pinpointed but the music appears flat, dull and lifeless. There are many valid arguments concerning the size and importance of these changes. However, if a lot of money is being spent on a sound reproduction system, in order to give the buyer emotional pleasure from listening to music, then surely even small gains are important.

If we get just a bit more technical with a few reasons we can mention that a good turntable increases dynamic range by reducing the noise level input. More information is then retrieved from the record because quiet areas of music and subtle

**A 3dB increase in voltage represents a 41.5 per cent increase.*

ambience information are not masked by the turntable noise. This phenomenon is more easily understood if we point out an elementary function of the human ear.

The ear has a mechanism for adjusting itself to the level of ambient noise. Thus our brain/ear combination tends to shut out any unwanted continuous background noise and tells us that we are listening to 'quiet.' In fact there is no such state as complete quiet but our ear tells us that general background noise is not heard. Most people living near a motorway learn to live with the noise of the traffic and do not notice it. In fact, background noises can get quite high (near airports, pneumatic drills, etc.) and still be ignored. However the constant action of the ear and brain shutting out this noise can create considerable stress which in rare cases can even lead to mental or physical illness.

We are not suggesting that turntable rumble will put the listener in the nearest mental therapy centre (!) but the same principles apply. All the noises from every turntable produced are audible to the average human ear but they are pushed into the ambient noise level and with them much of the subtle information from the record. So noise that we don't even hear is removing subtle ambience and position information from the record. At the same time, we are put into a position of minor stress because our brain is working harder than necessary.

One reviewer, when recently discussing the difference between turntables, said that he found it difficult to explain audible differences but that he was aware of a *'sense of ease'* when listening to a particular turntable (in this case the famous Linn Sondek). The phrase was written almost apologetically as if that was all he noticed. Probably unbeknown to himself he put his finger on the main important difference when listening to a record played on a better player. After all, hi-fi is all about a *'sense of ease.'* Our brain is trying hard to kid us that we are listening to live music. The less work the brain has to do, the more enjoyment we receive.

Another subtle technical effect, and to some people the most obvious, is that turntables alter the quality of the low frequency or bass from a record. This is partly explained by the previous paragraph, ie, the turntable noises that are ignored by the brain/ear are mainly of a low frequency, and the areas of music which are masked by this process tend also to be similar frequencies. However, there is another reaction which will be easily understood by those who understand loudspeaker theory. If one sound source produces a low-frequency noise of say 40Hz and another source produces the same noise, but exactly out of phase, and of the same level then the two sounds will cancel each other and nothing will be heard.

Therefore, a turntable with a 50Hz mains hum will completely cancel every bit of music that is out of phase and has the same frequency waveform and volume. This effect would probably be negligible but the problem is that louder notes will be partially cancelled and so will notes that are harmonics of 50Hz. Arms and cartridges have resonances can be excited by rumble causing output increases and thus wooly or boomy bass.

A final, important, turntable parameter is *'stability of the sound image.'* We are used to live sounds coming from all directions and being created with different degrees of echo (ambience). Furthermore, the ear is used to pin-pointing a sound source. The whole idea of stereo is to reproduce a natural image stage. If this stage is stable and the ambience realistic, the ear and brain will have to do less work. However if the images are fuzzy or keep moving the brain will become uneasy and tense.

All turntables distort the intricate phasing information which is necessary to produce images and ambience, and the degree of distortion will vary from one model to the next. The distortions are related in a complex manner to flutter and high-frequency feedback. Fifteen years ago many people were cynical about the value of stereo sound. Now it is universally accepted as being more enjoyable, and the previous paragraph-but-one explains the technical reasons. Unfortunately, many authorities (who should know better) still ignore the importance of the turntable's effect on the stereo image. Probably they have accepted that stereo is more enjoyable, have thought no more about it and now still persist in trying to measure wow, flutter and rumble instead of enjoying music.

We hope that we have given the reader an insight into the complex reactions taking place in the turntable when a record is played. Most of the explanations have been simplified to avoid becoming overtechnical, but at least we have shown that a turntable does more than just rotate a record! Unfortunately, very few turntable manufacturers are aware of the practical aspects of engineering a turntable to produce a high sound quality. Obviously all manufacturers have to compromise on cost, visual design, ease of manufacture, profit margin, etc., but turntable designers (and reviewers) should at least understand the basic principles behind record transcription so that these ideas can at least form part of the compromise.

It is ironic that some of the cheaper turntables sound more pleasant (or as good) as the more elaborate expensive models. This is usually due to the demand for speed control, stroboscopes and other gimmicks on higher-priced units. However, the electronics required to effect these generally unnecessary functions almost always degrades the overall performance. Until manufacturers and reviewers become generally aware of the function of the turntable (and it is possible that they never will) the situation for the musical public remains unclear. All we can suggest to the intending turntable purchaser is the following—go to a dealer who will let you relax in a chair, listen in comfort and enjoy the music you like; listen to an emotional piece of music and try to gauge your degree of enjoyment, *not* the hi-fi quality.

Listen also to the sound 'image' and try to judge the image stability, and how hard your ear is straining to pick out the instrument positions. This test is most easily done with a simple recording such as a solo singer with a guitar accompaniment. If a turntable sounds more pleasant to you and also sounds very slightly louder — believe your ears. The extra information retrieved from the record can sometimes give the effect of increased volume. If, after prolonged listening with the best available equipment, a cheaper turntable sounds the same (or even better) than a sophisticated model with thousands of knobs and lights, again believe your ears and remember that you are paying for the bunting and baubles.

Finally, remember that the overall sound quality of a record reproduction system depends on all the minute contributions made by every part of the whole combination. So every improvement, however small, is valid and if a number of inaudible improvements are added together then the net result can be quite important.

For those who are sceptical about the 'cranks' and 'eccentrics' that in every passtime search for that last minute degree of improvement, remember the Roy Gandy motto — *'All good things in life contain subtle nuances.'*

Turntable Thoughts by Paul Messenger

The sound quality of the turntable system is the most important single factor in determining the sound quality of the system as a whole, for the simple reason that the amplifier and speakers can only make the best of the signal they receive from the record deck. So, in choosing a turntable system, it is worth considering that it may have more effect than any other component on the overall sound quality. It is also worth emphasizing ergonomic significance, to avoid damage to records and stylus.

The more complicated the record deck becomes, the more sound quality compromises have to be made.

The prime function of the turntable system is to mechanically interface the disc and cartridge so that the cartridge is able to extract the maximum amount of musical information from the disc. To start with, we must understand that the "audio bandwith" is the range of frequencies the human ear can hear, and extends in frequencies from 20 to 20,000 cycles per second. Likewise the human ear can easily detect differences in loudness that encompass 60dB, or a ratio of 1,000,000:1. Even the simplest music is likely to contain enormous numbers of these frequencies at all these different levels at any one time, and the problem for the record deck (and the hi-fi system as a whole) is to get as much of this back as possible, while avoiding adding too much extra of its own.

To understand the dimensions involved in the record system we shall construct an enlarged model in which one micron (one thousandth of a millimeter) is represented by one inch. A midband modulation in the groove at a "typical" level (1kHz, 5cm/sec) gives a 16 inch peak-to-peak excursion for the stylus, while a 50Hz organ pedal at 10dB higher will require 10'6" and the low level harmonic of a violin (10kHz, -40dB) only 0.068"! A typical stylus with "line contact" profile on a high quality cartridge would produce vertical oval "footprints" on the groove walls 10" by 4" and would deform the vinyl by about one inch (twenty times the size of the violin harmonic). The stylus itself is about 30' high, and is attached to a bent pipe that represents the cantilever of 50' diameter and 275' length, extending from a 2000' long cartridge body that is some 80' from the record surface! The arm has a diameter of 450' and crosses 1300' above the record surface from its pivot point nearly four miles away! This approach deals only with dimension, not mass or velocity, yet it certainly illustrates the problems of relative magnitude that the turntable system has to deal with. In fact it is quite amazing that record decks work as well as they do, and it is hardly surprising that there are differences among them.

...TURNTABLE REVOLUTION...

Chris Rogers explores new thinking in Record Decks

Improvements in the design of turntables are yielding some pretty impressive specifications these days. Unfortunately aspiring customers aren't necessarily convinced that this justifies the significantly higher price, and to make matters worse there have recently been proclamations from rebellious elements that the latest breeds of turntable are not what they are cracked up to be, as sound quality doesn't bear up with the figures.

In order to gain a printed appraisal of the fallacy or merit of these arguments, we set Chris Rogers—known for his reluctance to accept any statement until he has proved it—the task of testing nearly a dozen different models. His brief was to spot differences in sound character and quality, and attempt to track down any link between sound and mechanics. The report he presents here discusses the areas he looked at, methods of test and finally the characteristics of the turntables. Naturally most of you will treat these reports as reviews, but beware, for strictly speaking they are examples chosen to illustrate a programme of research, and little or no comment is made of their aesthetic or ergonomic qualities.

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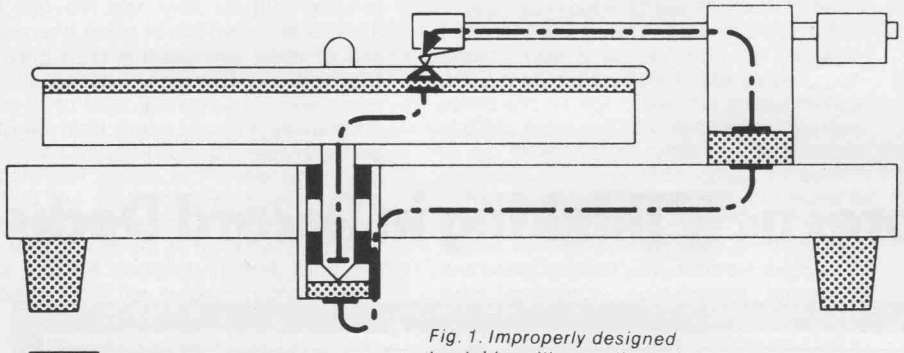

Compliant Areas

Fig. 1. Improperly designed turntable, with compliance in the wrong places.

The purpose of this investigation is not to find out whether turntables actually sound different, as it is quite obvious to any reasonable person that they do. What I am trying to do is consider a number of different turntables with the *same* arm and cartridge and try to identify some of the areas responsible for differences in sound.

The first question to arrive must obviously be 'why not measure the difference' ? Measurement, of course, would be fine if it were possible. Let's take a look at conventional measurements and see if they stand any chance of showing differences in a *use* situation.

Probably the first test to be attempted would be for rumble. 'Rumble' is the unwanted low frequency vibration and noise exhibited by the motor and bearing (also included in this definition will be the hum field exhibited by the motor). Noise from these two compartments can be either of a periodic or a random nature. Most motor noise is periodic, but it can include a very different range of frequencies associated with the mains. These will usually be in the range of 25Hz to 200Hz, which represents the slip frequency up to the 4th harmonic. Now we have our first problem! A given quantity of rumble can either occur entirely at one frequency or it can be spread over a range of frequencies, with each component of the total noise quite small. This problem can be avoided by producing an oscillogram or spectral analysis of the rumble, but here again the correlation of such a test result is next to impossible. With our present knowledge it isn't possible to make a meaningful assessment of a measured result of what we hear.

The next thing to be included in a rumble measurement is bearing noise. This can be cyclic in nature, starting at 0.5Hz (33rpm) and going up, or totally random. Random noise sounds like a 'shushing' noise. More usually rumble is a combination of both sounds: a 'shushing' noise varying slowly with turntable rotation. This surely is a very complex source of disturbance. Little is known of the effects.

Finally, 'hum' must be included in a rumble measurement. Hum is a little easier to define. It will inevitably be produced by the motor in the case of an AC motor on a belt drive unit or by a transformer in the case of a DC motor or direct drive unit. It is, however, broken into two categories — mechanical vibration (the factor usually responsible for motor rumble) and electrically radiated hum. It is the latter which will give rise to confusion. Radiated hum will be picked up by the cartridge, but different cartridges will pick up different amounts of hum in different ways, each having a totally different effect on the output. To add to the problem, this hum will be different at different points across a record, due to the cartridge being at varying distances from the hum source.

Summing up briefly, in a turntable we have a vastly complex sum of components which are usually dismissed as a single measurement. They are so complicated that it is *totally* impossible to correlate them, as we do not have any idea (in meaningful terms) of the subjective annoyance of any or all of these components. A bit of thought will indicate that these components will have a vastly differing effect on different signals and different frequencies, which gives rise to all kinds of summing, cancelling and intermodulating effects. Just to complicate the matter further, it is without a doubt desirable to minimise rumble as a whole but in doing this it is possible *totally* to destroy the disc playing set-up's ability to make an even half-reasonable job of playing a record.

Quantifying Rumble

So far we have only considered rumble in theory. It is in practice, in my opinion, *impossible* to make an accurate or meaningful rumble measurement. This is a sweeping statement, but it is not unreasonable. Our first requirement is a test *disc*, not necessarily a *record*. Rumble is often measured with a plain glass disc, but not only does it give nice misleading figures, it is totally useless. The use of a glass disc will only give an indication of vertical (mono) rumble, as there can be lateral modulation (stereo), and this surely is of equal importance. This means that a record with grooves cut has to be used, and here one major problem occurs. It is quite impossible to cut rumble-free discs, although some very laudable attempts have been made. A cutting lathe can never be totally rumble-free even if the cutting head is completely rigid (through such techniques as glueing it up solid). There will still be electrical fields and a small amount of bearing motor rumble to contend with, not to mention external vibration sources.

The point is that although there have to be accepted limitations to any measurement, the difference between the test disc and what we are trying to measure is in many cases non-existent. This fact alone makes nonsense of the test, if you consider that a turntable with say, 65dB rumble at 100Hz, is measured with a test disc with exactly the same rumble on it. If it just so happens that the two components are measured in phase you will get an exaggerated result. On the other hand, if the components are out of phase, total cancellation will result. However, what will be more likely is a slight degree of phase error, and just about any permutation of frequency components will result.

It seems valid to consider that if rumble components are of such low order and certainly much lower than that found on the best commercial music records it is pointless to try to measure them. But it must be considered that the same thing that happens in phase terms during measurement also happens when you play music, only to a far greater extent. So what in fact happens is that all manner of cancellations and additions occur, causing music information to be removed and distorted.

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Quantifying rumble

To make the situation more ridiculous, two other factors must be considered. The first factor is the measuring equipment, including the cartridge. Pick up cartridges are not necessarily linear transducers, particularly at the low levels we are trying to measure here. This assumption will cause error. The connections to the test instruments will have an effect even at such low levels, and finally, the measuring instrument itself will have an inaccuracy. When all this is added up, there could quite easily be an error in excess of 3dB. This may not sound much when speaking of rumble in excess of −65dB, but nevertheless this accounts for an error of 40% in audible terms.

The second factor is where and when the measurement is done. If measurements are taken during the day near traffic (not too near, however!) a far higher figure will evolve than if the measurement is made far from traffic in the dead of night. The condition of the mains used to drive the turntable will also have a pronounced effect. If, for example, the test is done in an area close to devices which do a lot of heavy switching, this will cause mains transients and worse results, but if the tests are again conducted late at night where there is little mains disturbance, results will be better.

All of this suggests two things. First, conventional rumble tests are totally useless. Second, I believe isolation is far more important if a turntable is to stand any chance of even beginning to work.

Wow and flutter

The other commonly used measurement of turntable performance is wow and flutter — cyclic variations. Wow is slow speed changes of 10Hz or less, while flutter is variation at higher speeds. This test for wow and flutter is usually done in one operation, but occasionally the two are separated. This division could be helpful if a few other factors did not exist.

The measurement is normally done at a single frequency of 3 or 3.15kHz with a sine wave record. The first problem is that even when both wow and flutter are separated, the flutter components are lumped together and shown in the specific frequency bands where they exist. The higher frequency components are subjectively more annoying. When using a test disc the first problem is to ensure that it is *perfectly* concentric if the test is not to be misleading. This is in itself quite difficult, but more important is the fact that the disc *is* a sine wave and as such produces a steady state signal. Unfortunately, music is not so accommodating, and it is here that the problem begins.

Wow has a totally different effect to that of flutter and must be considered separately. Audible wow can be very annoying, as a very off-centre record shows. But a more subtle effect is that of a turntable slowing during heavily modulated passages. This effect can dramatically reduce the impact of such passages, making the music far less interesting, although this is not totally due to dynamic wow effects. Small amounts of wow in subjective terms are far less objectionable than the same amount of flutter.

Flutter is responsible for all kinds of horror. It can remove all transient detail. It can destroy channel separation and hence stereo image. It is responsible for 'swimmy' images and the lack of all depth or ambience. Yet it does not necessarily show up on a steady state test. The reason for all this is not completely clear, but it is known that if a turntable does not have constant torque when the stylus meets a transient, it will momentarily slow down, causing the attack to be lost. This not only removes sparkle, but seriously affects the parameters just mentioned. I must admit that it does seem a bit far-fetched that a minute stylus can slow down the vast mass of a platter, but nevertheless it does, and sometimes dramatically! I would in fact be prepared to speculate that if a turntable has a poor constant torque characteristic, it may have a good steady state flutter measurement which could be 50 times worse under dynamic conditions.

From the foregoing discussion on wow and flutter I think it can be seen just where some turntables succeed and fail. Take, for example, a belt drive unit with a high mass platter: it should be easy for it to maintain speed, come hell or high water. If the platter mass is lowered, it becomes harder for the unit to maintain constant speed. If you add to this effect a low torque direct drive DC motor which relies on feedback and a servo system to maintain speed, this new unit stands little chance of working, as a servo does not work unless there is an error to correct. Consequently if the platter is slowed due to a transient, the servo will automatically speed up to correct for it. Then it finds out through the feedback loop that it is going too fast, so it slows down, only to speed up again. This alternation goes on constantly, making higher frequency flutter terrible. This factor alone is responsible for some of the early direct drives exhibiting a very distant wailing sound with no attack at all. Later types seem to combat this problem somewhat better.

I think that all of this shows the fallibility of conventional tests and indicates just how they have been used to mislead, although necessarily intentionally, rather than give any valid comparison of turntable performance.

What should we do

Now we come to the crunch: how *do* we evaluate turntables? First and foremost we ought to consider what our turntable has to do. The requirements are simple and few!

1) It has to support the record firmly.
2) It has to rotate the record at a reasonably accurate and completely constant speed.
3) It must provide a suitable platform for the pickup arm and cartridge.
4) The disc playing system must be in total isolation from its surrounding environment.
5) It must not add or subtract anything of its own.

The first point is self-evident, but it would seem to be overlooked by the majority of turntable designers. A record is a piece of vinyl which in itself has relatively poor mechanical rigidity. It therefore needs to be well supported in order to prevent it flexing or moving. Due to its inherent resonant properties it needs to be prevented from resonating, which means that its support must be very firm in order to prevent resonance rather than merely damp it out.

This requirement is not met if the record is only supported at a few points, which occurs with point contact turntables and also with the majority of rubber mats in current use which have only a few ribs here and there for the record to sit upon. This type of mat can, in fact make for disastrous

effects, because it has air gaps sealed by the record-producing sound boxes with resonant properties of their own. Thus occurs exaggerated surface noise and the phenomenon of changing character as these sound boxes are traversed. This relatively fundamental requirement appears to be flagrantly disregarded — either through cosmetic vanity or ignorance!

The second point, record rotation at constant speed, is where all the comment regarding conventional measurement arises. This function makes little concession to a practical in-use situation.

The provision of a suitable platform for pickup and cartridge would seem obvious. It often happens that an otherwise rigid platform is totally wrecked by the inclusion of a compliant mounting offering anything but a stable platform for the arm/cartridge More of this anon.

Suspension

The total isolation of the disc playing system is for many turntables the crux of the matter, and the point where they fail completely. Obviously, structural feedback will always be present. It results from traffic and aircraft noise, wind, slammed doors, etc, but mainly from loudspeakers; it is of low frequency in nature. Structural feedback should be reasonably easy to cure by the inclusion of a suspension or by good anti-feedback feet. It *should* be reasonably easy, but here again designers don't seem to know just what it is they're trying to achieve.

Suspensions are quite simple to understand in that there is mass in the form of the turntable and the suspension compliance. This mechanical circuit like any high pass filter has a low frequency cut-off point, determined by:

$$\frac{1}{2\mu\sqrt{MC}}$$

where M = mass, C = compliance.

More correctly, it will have two cut-off points, one due to the lateral compliance, the other to the vertical compliance. These points should be the same. Below these cut-off points the suspension will be inoperative, and in effect the turntable will be quite rigid. To add to the problem, the resonance will also have a 'Q' value (magnification factor), so the suspension should also be damped. Without damping, the suspension would probably have too high a 'Q' value. The result would be oscillation should the resonance frequency be excited. At the other extreme, should the damping be too great, the suspension would become inoperative.

For a suspension to be effective it must have a cut-off point below the lowest frequency to be reproduced and be damped so as not to have a 'Q' greater than unity, or else there will be resonance. It is also worth pointing out here that if the suspension is properly arranged, it will be useful below its cut-off point, much in the same way that a loudpeaker has useful output below its resonant frequency.

In practice, what one often ends up with is a turntable which has a suspension with a resonant frequency quite high in the audio range (in excess of 50Hz) with a high 'Q' resonance. The audible effect of this is a 'boomy' sound, with precious little information below it. Unfortunately, the effect is too often blamed on the loudspeakers or the room, but it should more correctly be attributed to the turntable. The result, if the 'Q' of the resonance is not high, is that the boomy effect should not become obvious, but the sound will probably become thick and muddy. An example illustrates the point. I had a system to review recently, including a cartridge with which I was familiar. I knew it had a very tight and detailed bass end, but when it was mounted in this particular system's turntable, the bass end became very muddy and indistinct. Without prior knowledge of this system, I wonder how many people would have blamed the cartridge, quite wrongly!

So far I have only considered one aspect of feedback, the structural component. Probably worse is the effect of acoustic air-borne feedback. This will have a pronounced effect on everything with which it comes into contact, because sound itself is an air-borne mechanical force in much the same way as structural feedback.

A turntable used in a room with loudspeakers is obviously going to receive just the same amount of information as our ears. In the case of transients or low frequency, heavy modulation can give a very high SPL.

To clarify the position, consider for a moment that every single part of the disc playing system will be subjected to the sound, and that every part of the turntable has physical mass and is capable of resonance. Not only this, but most turntable parts are also capable of storing that energy unless they are well-damped, and then they should not resonate in the first place.

It might be thought that this effect could only be small, but don't forget that the subtle information on a disc may only be fractions of a micron in size and that any resonance approaching this magnitude will totally destroy the source signal! Any minute resonance set up in the turntable will have a pronounced effect on the music. Remember also that an item in resonance will have a complex resonant structure which could be totally unrelated to the frequency which set it into motion. Hence a single feedback frequency can have far-reaching catastrophic effects. Air itself can also be set in resonance, so any air cavity within the turntable such as that within the plinth will also be excited.

Perfect coupling

To return to the list of parameters, item five, that turntables should neither add nor subtract anything, is not really an isolated point. It is the sum of the preceding points and it should be the nett aim of a turntable designer. As such it is the object of this report.

As mentioned earlier, it is possible to design a turntable that will measure well in terms of rumble and other steady state measurements but which will sound pretty bad when used in the normal way to produce music with loudspeakers.

To establish the reasons for this it is first necessary to understand the mechanical requirements when playing a disc. The main parameter is simple. The modulations in the record groove must excite the stylus in order to produce an electrical output from the cartridge. It seems many designers *do not* appreciate this point.

In order to achieve the objective, one criterion must be met. This again is quite simple, and it is that the record and stylus must have a completely rigid relationship with each other. If there is any movement other than the required stylus excitation, two things will happen. First, information will be lost; second, the information that is obtained will be distorted. I am sure that explanation is simple to follow, so can someone please explain to me why disc playing systems are designed so that this does not happen — even to the point

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of manufacturers advertising the fact that it doesn't.

A look at Fig. 1 will illustrate where these gross design errors exist, destroying the rigid coupling. The first place is the turntable mat. If this is springy and compliant, coupling is broken. A soft pad at the bottom of the main bearing allows compliant vertical movement, and finally, a compliant mounting at the base of the arm allows the arm to move in relation to the rest of the system. Incidentally, there points exclude the antics that arms get up to.

I think it is quite simple to see that any one of these design faults will destroy the record/stylus relationship and make quite a mess of the music. A few tests will reveal that most of the compliant mountings have a resonance in the mid and treble frequencies. It is because of this many turntables have faults such as poor, or shifting, stereo image, loss of treble detail, distant mid and treble, harsh gritty sounds and a host of other nasties.

Now take the other tack and consider what will happen if steady state measurements are performed on a turntable with *all* these faults plus a set of high resonance feet. The answer is quite simple: all these faults will *decouple rumble and other mechanical vibrations in exactly the same way as they destroy the music.* Added to this, the high resonant feet will probably have been designed to absorb motor vibration. Thus the job's complete — the turntable's performance *measures* extremely well, but can't play *music.*

If all these faults are removed, the measured rumble performance would probably be much worse, but, and this is a big but, the improvements these faults are designed to give are probably nothing more than a measurement of the turntable's ability to destroy information over its performance without them.

Misguided cures

The next peculiarity is that if some of these faults are rectified, the audible result may be worse. The reason here is quite simple. These faults are engineered in order to mask other shortcomings which could well have worse audible effects. One good example of this is that a thick rubber mat could prevent a platter ringing badly. Care must be taken, however, to ensure that the mat has minimum springiness in order not to decouple the system. In other words, the platter mat is a cost-conscious compromise. A far better result could be obtained if the platter were either damped on its underside and the mat made only to achieve its own objective, or the platter were redesigned not to ring in the first place.

If, however, the system is poor in the first place, such tricks as decoupling the arm will only serve to make the sound worse. The maxim here is 'you can't make a silk purse...'

The foregoing, I feel, shows just how fallible conventional turntable tests have been. The alternative, however, is not quite so simple. To make a quantitative subjective assessment of *any* single piece of equipment is not straightforward. It is very simple to sit down, listen, and say that 'that sounds bright' or whatever, but *what* actually does the 'sounding'? Is it the piece of equipment under test, some other part of the system, the environment you are listening in, the incompatibility of the test item with other parts of the system, or just that you don't like the piece of music played in the first place?

It is therefore essential to be familiar not only with the rest of the system used but also with the listening environment and the reason for the exercise — the *music*!

Setting for tests

All listening tests here were carried out in my own listening room and with records known well and liked by the listeners. The rest of the system was as follows: loudspeakers — PRO9-TL; power amp — my own 50W valve amp; pre amp — Lecson AC1. The problems of disc playing were eased because all turntables were used without pickup arms, so each unit could be fitted with the *same* arm and cartridge. In choosing an arm I had to find one which was of known good performance that could be changed without any problem. This wasn't easy, and my final choice was the Grace G707. There were a great many problems selecting the cartridge. One problem was that there is always a possibility of the arm cartridge resonance falling at a coincident frequency with a resonance in the turntable; such things must always be avoided like the plague. The chosen cartridge must, of course, be able to extract as much information as possible from the grooves. As such I selected a cartridge which I have been using a lot recently, the Satin M-18E, a high output moving coil type.

The arm cartridge was then correctly set up on each turntable, so that it was possible to change it from one to another with no problems. A check each time with an alignment protractor was all that was necessary to ensure everything was right.

Listening tests were conducted virtually daily over a period of several weeks in varied formats. On some occasions we listened to units in quick succession, with maximum time between samples of about two minutes or less. On other occasions only two units were auditioned at a time, and comparisons made between them. Finally, considerable time was spent listening to each unit as a separate entity and performing tests such as listening to the samples with different mats, with lids raised or lowered, with lids removed, and in different locations. Placing the turntables in a different room from the speakers proved very interesting.

This is the outline of the nature of the tests conducted; it forms the basis on which the comments were made, including, of course, a visual inspection of each unit in engineering terms.

TEST REPORT

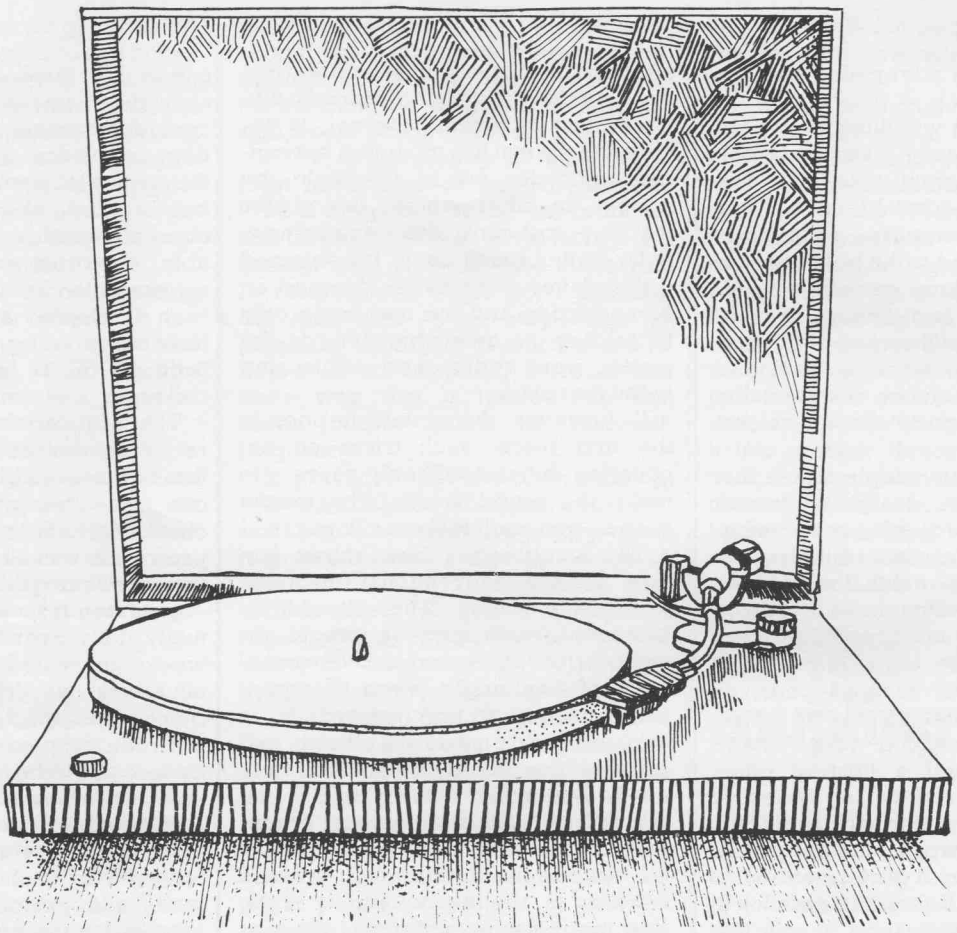
Rega Planar 3
by Ivor Humphreys

Of a design and presentation which seems almost too naive to be true, the two Rega turntable combinations have earned an enviable reputation over the years for being almost the only downmarket alternatives to the ubiquitous Linn Sondek unit, sacrificing comparatively little in terms of sonic performance while costing rather less than a third and including a very respectable arm to boot.

So well regarded is this simple little arm by the top end cognoscenti that it has been partnered quite happily with many a Linn turntable.

Sonically the Rega turns in an outstanding performance, with excellent detail, no obvious response anomalies, first-rate and stable imagery with very good depth.

REGA PLANAR 3



This is a simple two-speed belt drive unit which has been developed to achieve a good audible performance. This quest has led its designer to incorporate some unusual features.

The most striking feature is the plate glass platter 12mm thick, weighing some 4½lb. The platter sits on an injection-moulded plastic hub around which the round section belt runs. The bearing spindle, of course, is pressed into this hub, $\frac{5}{16}$in. in diameter and the bearing itself is brass with a steel ball for its thrust pad.

Returning to the drive system, we find that the motor is of synchronous type suspended on a rubber mounting with a plastic pully pressed onto its spindle. The speed change is manual, which requires lifting off the platter in order to move the belt from one pully to another.

There is only one control on the Planar 3, a neat on/off switch at the left front corner. The plinth is constructed from 1in. thick chipboard and covered with a Formica-type laminate. On the underside there is a small moulded plastic cover, beneath which are the motor and associated components. The unit stands on three shock absorbing rubber feet since three feet are more stable than four, as it is not possible to rock a tripod.

The cover for this unit is a smoke tinted acrylic moulding, probably among the best I have encountered. Incidentally, it was not possible for Rega to get this lid manufactured in the UK without ordering millions, therefore it is made in Denmark.

The Planar 3 is usually supplied with its own arm developed by Rega and made for them in Japan, but for this review it was not used.

Engineering

A close inspection of the Planar 3 shows that it is constructed to a very high standard. The bearing is made to extremely close tolerances and has a very fine finish on the spindle. If the bearing is clean it will spin for a very long time. It is normally lubricated with a quite thick high pressure oil, however.

The laminate used to cover the plinth was selected for its solid, hard nature. It makes the whole assembly extremely rigid and adds to isolation from feedback. Careful selection of the phasing capacitor used in the motor has led to a very low level of vibration in this area.

The mat is $\frac{1}{8}$in. thick and made from felt.

On Test

Listening tests proved to be very pleasing, with few 'nasties' encountered. Isolation from structural feedback was not exceptional, but the sound was very clean, as only a dull thud came through if the surface on which the unit was placed was tapped. There was no tendency toward any ringing or continuation of feedback.

With the unit placed in another room there seemed to be no discernable difference.

Changing the mat proved interesting. If *any* rubber mat was used the performance became worse; therefore, it was decided to use no mat at all. This showed up a ringing sound with a roughening at the treble end, attributable to the small resonance in the glass platter. Using the thin Linn felt mat removed the roughness, but the sound was still considered a little bright. Reverting to the normal mat, the brightness vanished, and it was felt that the sound dimmed a little. Taking all these things into consideration I must say, however, that I am referring to small changes. The choice which Rega have made is an effective compromise and one with which I could live. In fact, it says a lot for this humble turntable if such small changes are audible. It's a praiseworthy product to be recommended.

Postscript

The Rega arm I have auditioned in its own right and I can report that it complemented the Planar 3 very well. It's effectively compatible with a wide range of cartridges.

CONCLUSIONS

There are several aspects of design which I feel are worthy of comment in general terms. First of all, I think it fair to say that with the exception of the Environmental Sound EST4 the standard of construction of all units in the group is first class and as such, it is beyond criticism. However, the same cannot be said for designs.

I consider it fairly obvious that the bulk of these units have had their main design work done by electronics technocrats and not by mechanical engineers. This is made evident by the vast electronic complexity utilised before basic mechanical parameters have been satisfied.

It is obvious that the fact of a cartridge having to maintain an exact and precise relationship to a record is not well understood. The principle, at least, is not too well applied in the units presented here. It would seem that only two samples have considered this, the Linn Sondek and Rega. All the others do not satisfy this requirement in anything like a satisfactory way. The first and most obvious area is the mat, where most fail badly.

Sony have made an effort to prevent record resonance but have failed to realise that they have only decoupled the system. Micro have introduced a cork decoupling layer seemingly on purpose plus a springy mat, while it would seem that Sansui and Toshiba have also used a springy mat to damp their platters, not realising what else they are doing. Lux also fall into this category, but at least they have attempted to make a better job of it. Perhaps most unforgivable is JVC, who have made a well-damped platter but still used a mat which is springy and decouples.

Moving on to the area of main bearings, it would seem that again it is only Linn and Rega who know what is happening. Whilst *all* of the bearings are of high quality and some are higher than others, it is only true in the sense of the plain bushes and spindles. On the subject of thrust pads, only the two mentioned have a solid type that do not decouple. All the rest have soft synthetic types, the Sony perhaps the softest and the Sansui the hardest, and all of them are inadequate.

The next area is plinths and suspensions, which work in conjunction with each other. As is seen here, there is an increasing use of the 'Resinamic' material. This has very sound reasoning behind it in that the added mass of this material should be inert. This is true, but what is not considered is the way in which it transmits vibration.

The Sony sample is particularly suspect in this area. In order to make such materials work well they need a very low resonance suspension in order to prevent vibration getting there in the first place. JVC have used a particularly good laminated plinth which does not transmit very much. Rega, on the other hand, utilise a very hard plinth which is quite light. This has the effect of rejecting sound in the first place. Finally we come to the Linn, which has a sub-chassis within the main plinth with a low resonance suspension and does not suffer with many of the problems inherent in other forms of suspension. To take a brief look at the system, it is immediately obvious that it does not suffer very much from air-borne feedback. The areas which are prone to this form of feedback are greatly reduced by such appendages as the lid and top plate being isolated from the main working assembly. This in itself removes a severe limitation. In general terms, the suspensions used are invariably inadequate, having far too high a resonance which, in turn, offers very poor isolation external disturbance.

Belt v. direct?

So far I have not mentioned the controversy of direct drive versus belt drive. Whilst I am sure that the direct drive units we have been used to have some severe limitations in terms of torque and high frequency flutter, it is my personal opinion that the direct drives now being developed by such companies as JVC, Sansui, Sony and, although not included here, Hitachi, and the father of direct drive, Technics, are well on the way to solving some of the problems inherent in the system. However, what I do consider sad is that even the systems in existence don't have a fair chance of success by virtue of the points already mentioned. It would seem that the drive system could be capable of far better performance that it is allowed to give.

Although I have painted a rather bleak picture, it is not without hope. I am sure it will not take enterprising companies long to realise the error of their ways and soon start to include sound mechanical common sense into their turntables, after having gotten over their electronic exuberance.

Performance in brief

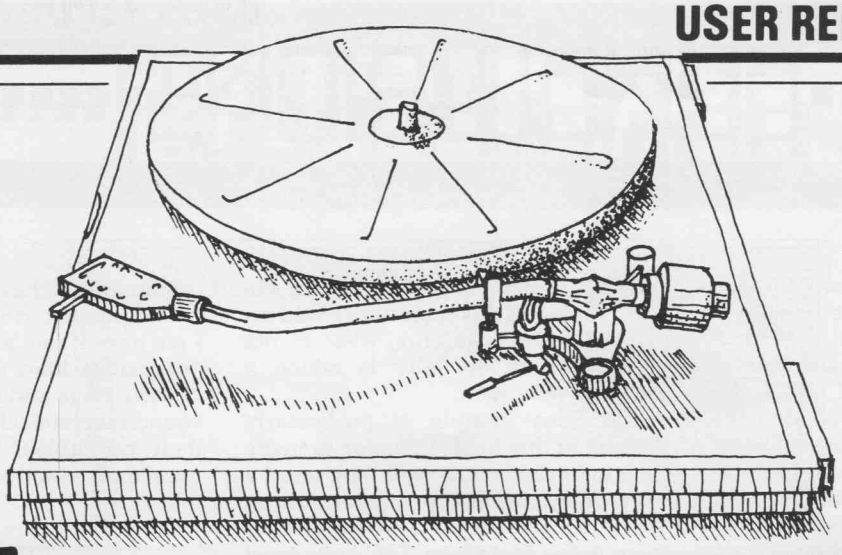
To state an absolute order of merit is not possible, but I will endeavour to give some indication. At the top of the list is the Linn-Sondek LP12, which stands head and shoulders above the rest. Whilst its belt drive system seems to be superior to other drive systems, I am sure that the main reason for its success is the designer's ability to identify problems and requirements and go a long way further to solving them than others have done.

Next in line is the Rega Planar 3. This modest little turntable is not far short of the Linn in general terms, and it is perhaps the best value for money product on the hi-fi market today.

Following on, the JVC offers a standard of performance in excess of others of its type, albeit at a high price. Also, the DDX-1000 is capable of good results, but which I am sure could be a lot better.

The Sony and Sansui models are let down by faults which, if cured, could make them an attractive proposition. The Luxman PD-131 has some areas to commend it, including an appearance which, I personally find superb, but I feel it suffers from a rather dated motor system and several other points. The Toshiba SR-370 also suffers from an ageing motor system and poor platter. Also rather disturbing is the resonant lid which is coupled to the drive system and is quite audible. Finally, there is the Environmental Sound EST 4. This unit, I feel is very poor and hardly worthy of consideration.

There are a great many other points arising from this investigation which lack of space prevents me discussing. I must offer thanks to the many friends who have lent their ears to this test, all of whom have my deepest gratitude.



Why we recommend the Rega Planar 2

Rega Research are a small British company offering a diminutive range of products to an already overcrowded market. Sounds like commercial suicide, but one redeeming factor has ensured their success — quality. Anyone who has even glanced at our Query section lately will have come across many a mention of the Rega Planar 2 turntable which offers unequalled performance. Virtually all our contributors have come to the conclusion that this deck is something special so we thought we'd ask them all for a little more information. Graham Holliman kicks off . . .

A few weeks ago I was given the opportunity to try out a friend's Rega Planar 2 turntable, complete with its own arm. When it was brought to me, my first impression was one of pleasure at the way it was styled, and the quality of its construction — it created an impression of quality right from the start. The designers also seem to have thought of a number of little things which combine to make this deck a delight to operate as well as a joy to behold.

The unit is supplied with a beautifully made smoked perspex lid. This is hinged at the rear of the deck, but the hinges allow it to be removed completely, if desired. This particular deck had a baseboard which was faced on its narrow edges with wood of a 'tawny oak' colour and which contrasted very pleasantly with the smoked perspex lid.

The upper surface of this board was black, and the arm, which was a very neatly engineered design, was of a silvery colour, and was fitted with calibrated rotary controls for setting up the playing weight and bias adjustment. These latter controls were particularly easy to operate and gave a strong sense of precision and smoothness as they were used to set up the deck for the tests.

This turntable platter was made of a very thick piece of glass, suitably ground. This platter rested on a sub table/pulley wheel assembly which appeared to be made of a special type of plastic. The table mat was of hard rubber, with a large number of thin radial ribs to support the record. As it happens, the owner had also fitted it with one of the earlier ADC cartridges, which matched the arm particularly well, and was also an outstanding performer.

After my initial enthusiasm for the mechanics, I was eager to hear what audio quality the unit could produce, and I was not to be disappointed. It was clear right from the start that here was a turntable and arm combination of the very highest calibre — indeed, my first impression was that here was a combination which surely must be a serious rival to the renowned Linn Sondek LP12/Grace setup! But more of this anon.

We tried the unit out on various types of music programme known to be of high quality, from past experience, and throughout these extracts there was a very noticeable sense of clarity and spaciousness present.

The realism was first class. The unit was also compared directly with another turntable often used as a reference, and again, there was very little difference indeed. There can be few units, at any price, which are capable of giving such a near perfect performance.

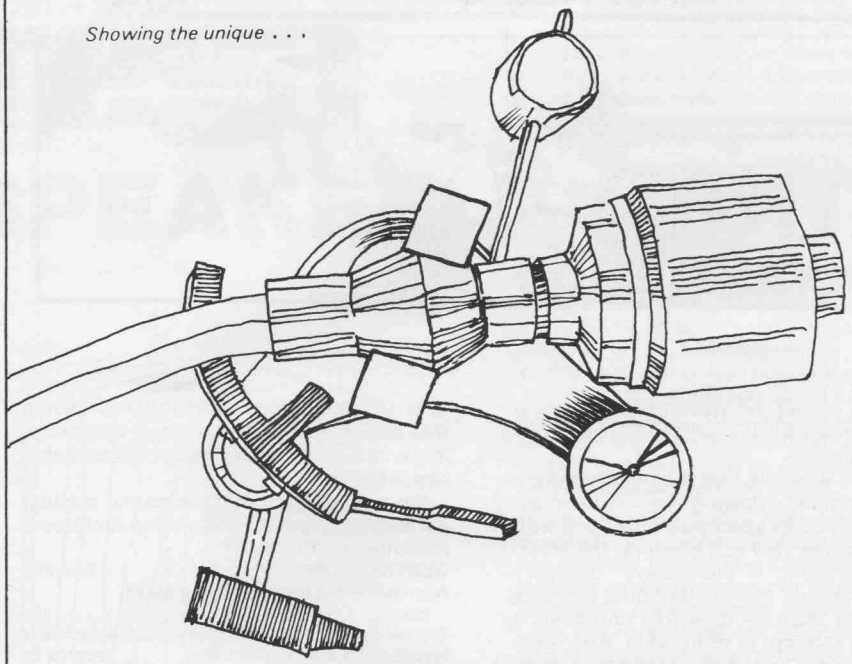
I was going to say such a faultless performance, but I have in fact a couple of observations to make on the negative side. Firstly, on very high level 'direct cut' disc material, it was possible to detect a very slight harshness on such things as piano notes, played heavily. It sounded as if this might be caused by slight rattle in the arm bearings, and these were indeed found to be adjusted slightly looser than was absolutely necessary. However, far better this way than for them to be too tight!

The second point is almost academic. With the volume set very high, and the HFS75 rumble test on the table, no significant turntable rumble could be heard, but the motor itself was audible, giving a steady hum which disappeared on lifting the stylus from the record. This motor hum was, however, so quiet that at ordinary listening levels it might easily have gone completely undetected. In fact the same type of motor hum was also audible on a Linn tested a short while ago, but this was at a lower volume level still, and was completely insignificant in practice.

The Rega arm seems to be of higher mass than normal, which I consider to be a good thing provided that a suitable amplifier is to be used which doesn't overload at low frequencies. It also suffers less from mid range resonances than most of the competition, and it appears to be easily good enough, in all respects, to track the best cartridges available. The total friction of the arm bearings and the bias setting device is very low indeed, and I believe that additional counter weights are available to plug into the end of the arm, thus allowing an increase in headshell or cartridge mass to be accommodated, or for infra bass purposes.

In fact the cartridge used in the reference system was not tried in the Rega arm, but the old ADC cartridge fitted to the Rega was transferred to the reference turntable for an accurate comparison, and with the exception of the

Showing the unique . . .



Solid and sensible arm design . . .

criticisms already made, the reproduction was of at least as high a quality on either unit, and the old ADC in the Rega was marginally more musical than the reference cartridge when fitted to its own turntable/arm combination.

To the person who said that 'This turntable is the best thing to happen in England since the invention of sliced bread' all I can say is that I entirely agree with his sentiments. It would be very hard to imagine a significantly better turntable/arm combination (not necessarily even by the same manufacturer) at any price — at this price, what else is there to be said?

It also has the benefits of very great ease of operation, which is more than can be said for some of the competition. Its audio quality is not affected by acoustic feedback. It is a *two* speed device, although one has to remove the platter and transfer the belt from one pulley to another by hand in order to make use of this facility, which would make it unsuitable for the very old, the very young, and the infirm, if more than one speed is to be used regularly.

I would like to express my thanks to Mr. Charles Matcham, for the loan of his Rega Planar 2 and for assistance in carrying out these tests.

Peter J Comeau was astonished . . .

The first time I heard the Rega I was astonished. Up till then the Linn Sondek had been the only turntable I felt gave an accurate account of the information on the disc, but the Planar 2 came very close to it, and at a third of the price.

Like the Linn the Rega design is very basic, and therein lies its strength. By adopting a plain wood sheet for a plinth it has reduced acoustic feedback which often occurs in box type plinths, and offers a stable base for the rest of the deck to sit on. A carefully chosen motor gives good torque and low external stray fields — unlike the Linn there is a stepped pulley for 33 and 45 rpm which is useful for the recent direct cut discs if nothing else! Whoever chose glass for the platter deserves a medal. It not only offers a heavy, perfectly flat surface of even weight distribution, but is remarkably free from the 'ringing' effects that normal cast metal platters give.

Rega have chosen their arm well too. It is very rigid, has low bearing friction and is of medium effective mass and seems to suit the majority of cartridges from the low compliance FR1 moving coil to the ADC XLM Mk2, and I have even heard reports of the Sonus Blue being used successfully in it.

Altogether it is pretty obvious some thought has gone into this unit, and this shows in the subjective performance. Rega dealers, and there are precious few of them, are quite prepared to demonstrate the difference between the Planer 2 and any other deck you care to mention, and it soon becomes obvious that it is outstanding in its class. Basically the design approaches previously outlined leave the record and cartridge to perform with minimal interference, and the loss of recorded information is therefore small. Faults do become apparent when testing against the Linn, or even Rega's own Planar 3, and these exhibit themselves as a slight muddling of detail together with a slightly recessed overall quality. The Planar 2 is supplied with a plastic mat, and using a felt mat reveals more treble detail but allows a slight 'tinniness' to come through which perhaps is due to the platter. However these effects are mild departures from perfection, and comparison with other decks in any price range showed that the Planar 2 was way ahead of 90 per cent of them.

It is this sort of quality which endears a turntable to the reviewer and to the public. Unfortunately the two do not go hand in hand, so although I go on recommending them in system queries, they are always in short supply. Rega are a small concern, seem to want to stay small (that is where the quality lies), and are dedicated to export. So dear British reader, if you want one please be patient — it will honestly be very worthwhile.

Chris Frankland saw no great mystery . . .

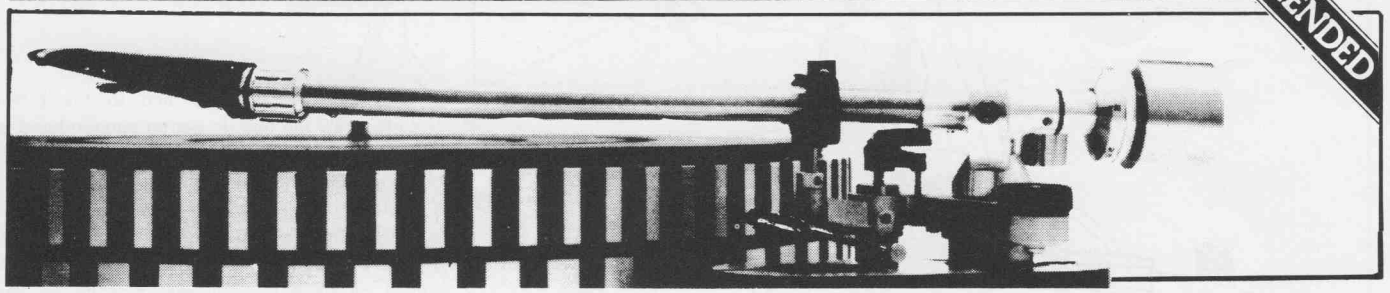
I must say that when I was initially asked by our good editor to add fuel to the fire of the great 'turntable sound' controversy, I did not react with great enthusiasm, but having grasped the opportunity, let me start by saying that there is really no great mystery. It is not that turntables sound different as such, it is rather that some turntables seem to allow the arm and cartridge to do their job more efficiently, thereby retrieving a greater amount of detail from the grooves. The key to a good turntable really hinges about retrieval of detail, in which we count such intrinsic qualities as recorded ambience and 'depth' of sound stage.

The key to the success of the Rega Planar 2 and 3 is that the manufacturers have sat down and consciously set out to optimise those factors which they have found to affect sound quality. I do not have space here to go in detail into what these factors are, but suffice it to say that the main bearing of the turntable is of unusually high quality and precision, as is indeed the motor, two factors, which together with the plate glass platter, go to make the Planar 2 as good as it is. The glass platter not only offers the virtue of evenness of mass, but it is inherently less resonant than its aluminum die-cast lightweight rivals on Japanese decks.

The audible results are striking. The Rega simply brings out previously unheard details in the recording. It has an extremely clean, tight bass end and a very smooth, detailed midrange without the forwardness one all too often encounters. Imagery has greater solidity and the sound stage spreads back behind and away from the loudspeakers, resulting in greater ambience of sound. It becomes easier to distinguish between players in an orchestra or members of a rock group. Vocals and speech suddenly become more natural and out-of-the-box in character. If you like, the Planar 2 puts the emotion back in to the music. It is difficult to put it into words, even though the differences which exist between the Rega 2 and other similarly priced turntables are immediately obvious. I have compared the Rega 2 with many good belt drives and direct drives costing up to twice as much, and the Rega still allows more detail to be heard and offers a generally cleaner and better defined sound. It must certainly be one of the best hi-fi buys on the market today.

Rega R200

RECOMMENDED



Rega

Due to long supply delays, we acceded to the manufacturer's request not to include the Rega turntables on grounds of unavailability; however, the arm is available as a separate item via their dealer network.

Koshin are a noted Japanese manufacturer of pickup arms who supply special custom-made versions, Rega Research being one of those companies who buy arms for their own range of turntables. Superficially, the Rega looks like an archetypal Japanese arm with detachable universal headshell fitting and the usual rotating scale/counterweight assembly; in fact, Rega have controlled a number of manufacturing details in order to optimise the design, including bearing tolerance and accuracy, main arm tube material, and a special side-entry low profile cable fixing. The engineering standard was clearly high.

Bias compensation was specified as magnetically energised, although we were not able to check this, but certainly no additional friction resulted from its operation. Height adjustment proved none too easy but could be accomplished using packing nuts on the pillar. No tilt provision was made.

Friction was low and the bearings were well adjusted, showing very little play. Downforce calibration was within 5% with cue operation very satisfactory, the effective mass being in the "heavy" category at an estimated 16g. No damping was provided and the use of a low compliance cartridge (8-15cu) is preferable. Arm resonances were classed as about average; although the obvious resonances at 300Hz (first break), 650Hz and 2.6kHz were quite severe, the intervening areas showed good control, and the even energy distribution above 2kHz was promising.

Fitted to a reference player, the Rega arm was considered to deliver a good standard of sound quality. While the bass register was a trifle generous, good depth and localisation were evident, but mild mid coloration was apparent—a coarsening of upper range information and a 'tubey' effect. This coarsening lent a touch of sibilant splash, but despite these qualifications stereo image depth and detail held up well and overall the impression was better than that given by a number of more costly and well known detachable headshell models.

On a good turntable the sound quality/performance/price relationship dictates a recommendation.

GENERAL DATA Tonearm

Approximate effective moving mass (excl cart, incl. screws)	16g
Type of headshell	Universal detachable
Headshell mass (incl. screws)	approx 8g
Geometric accuracy	good
Facilities for adjustment	overhang, (height by packing)
Finish and engineering	very good
Ease of assembly/setting up	very good
Ease of use	very good
Friction lateral/vertical (typical)	25mg/<10mg
Bias comp: type/force rim/centre	magnetic/100 mg/115 mg
Cueing: drift/8mm ascent/ 8mm descent	negligible/2.5secs/2.0secs
Downforce calibration error 1g/2g	-0.05g/-0.1g
Amount of damping	none
Arm resonances	average
Subjective sound quality	good
Motor recommended	LP12, Rega etc
Arm lead capacitance	85pf

Quest test

The Rega Planar 3 is normally supplied with the excellent R200 arm which has been around in one guise or another for several years now, and represents one of Hi-Fi's true bargains. It is a suitable platform for many moving magnets and moving coils, and is generally manufactured to a consistently high quality with regard to bearing tolerances and finish.

The simplest and cheapest of all the turntables here, the Rega Planar 3 has acquired an almost cult following over the past couple of years and although it is regularly recommended in these pages supply has meant that reviews are hard to come by. A small dedicated group of dealers stock Rega and believe very strongly in its sonic powers, many of them will cite it as being the only deck to buy if you cannot afford a Linn.

My own experience of it has been fairly limited though I owned a Rega Planar 2 a while back and the Planar 3 is a development of that deck with selected tonearm, bearing etc. The Rega is available with or without arm, although they are generally supplied with the Rega R200 tonearm that has itself played an important part in this test. So what does the Rega offer and how good is it?

In common with the Focus One, the Rega Planar 3 is a plain wooden plinth but the motor is mounted directly behind the main bearing and drives the small plastic inner platter through a very short circular section rubber belt. Again two pulley sizes enable 33 or 45rpm to be manually selected. Interestingly enough the motor is decoupled beneath the plinth and has free movement over a short distance. The platter is in two parts. The inner part consists of a small plastic disc which holds the bearing spindle and is itself driven by the belt while the main part is a half-inch thick heavy piece of glass. The bearing is of superb quality and I suspect it is this that takes a large proportion of the manufacturing cost.

Controls are few, one to be exact, a small round rocker switch to start and stop the motor. A fairly thick felt mat is supplied as standard and the standard of construction is very good if a little austere. But then with the Rega Planar 3 you only pay for that which is essential to the performance of the deck—forget the frills.

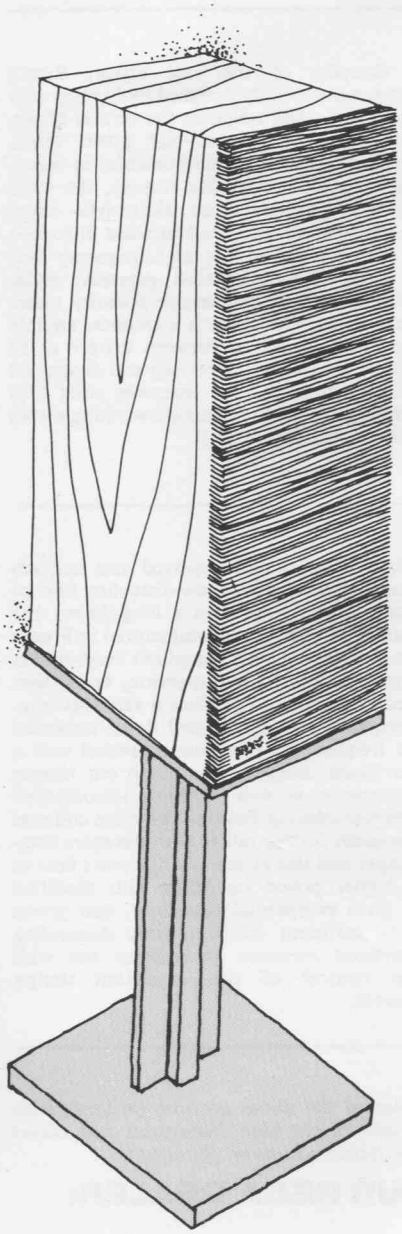
It did not take too long before I realized that in certain areas the Rega is a cut above the other units here. It has a superb sense of ease and separation, most especially in the all important midband where the coherence detail on multi-track vocals for instance set it apart from all the other decks. I found the vocal quality, sense of perspective and ambience was a class above the Thorens which could begin to sound hard and a little thin in comparison. At the top end too the Rega was beautifully delicate and transparent but with excellent dynamics that can give good insight into recorded effects.

The Rega has a firm, detailed low end performance and deserves its reputation as an information retriever. For sheer intelligibility the Rega Planar 3 has it. You can hear notes stop and start, vocals become clearer, rhythms are more easily understood than on the other three turntables which tended to sound "slower" and less dynamic.

Another interesting thing about the Rega sound is its lack of surface noise and in this respect it was the most unobtrusive of all the decks which indeed is one of the virtues of the Linn Sondek with whom it shares certain characteristics such as its good clean dynamics throughout the frequency range and solid stereo images which do not move with level.

Soundwise there seems little if anything to beat it at the price and with a good arm and cartridge you have the basis of an excellent system. The long waiting lists seem to be on the wane now although Rega dealers may take a little searching out.

THE rega SPEAKER



ART CONFRONTS SCIENCE IN LOUDSPEAKER DEVELOPMENT

Rega Research has for some time believed that many audio products are unacceptable compromises. Reasonably-priced products all too often sacrifice sound quality, while acceptable sound quality is usually overpriced. Rega Research confronts this conundrum by foresaking cosmetic, non-essential frills and concentrating on the ability of a product to reproduce music accurately. This approach was first applied to the highly successful, world-acclaimed Rega turntable - still the lowest-priced audiophile-quality turntable made. A thorough examination of loudspeakers also revealed the absence of a non-compromise, audiophile-quality loudspeaker at a reasonable price and this led to the development of the REGA LOUDSPEAKER. To appreciate fully how successfully Rega has accomplished its goal, the Rega loudspeaker must be compared with products costing considerably more.

Loudspeaker design is less than a precise electroacoustic science. While measurable data can correlate with certain sonic properties, it is incorrect to assume that measurement alone will adequately describe sound quality. Unfortunately, present knowledge of how music is perceived and the significance of various distortions and colourations is far from complete. For this reason listening tests remain the final arbitrator of sound quality.

In the development of the Rega loudspeaker, hundreds of hours of listening by both musicians and audio professionals have been supported by a thorough laboratory development program to provide you with a loudspeaker of exceptional musical merit.

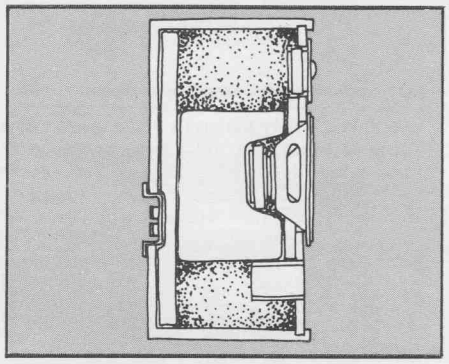
A careful examination of the most respected loudspeakers available indicates that there are no ear-shattering technological breakthroughs to account for superior sound quality. The use of exotic and costly materials - the latest this and the newest that, here today and gone tomorrow - make good advertising copy but contributes little to the sound. The basic principles of loudspeaker development are well-known, but what distinguishes the top loudspeakers, aside from their high prices, is the painstaking, laborious, and methodical development of these principles, the use of only the finest-quality components, and a fastidious attention to details that affect sound quality. The Rega loudspeaker shares this approach and considers no detail too insignificant to be ignored - only the inflated price is absent.

Rega's thoroughness is evident in the individual drivers, the crossover network, the cabinet, and the numerous tuning details that affect amplitude/frequency response and directivity. Individual damping materials are incorporated in the cabinet design for both high and low frequencies to reduce colourations, and the drivers are critically positioned to provide optimum stereo imaging in both width and depth. The bass/midrange units are individually selected and modified to obtain the results demanded by the Rega design and the high-frequency unit is identical to that found in loudspeakers costing up to five times the price. Together, the drivers offer the best combination of individual response characteristics and compatibility.

Since it is unlikely that your audio expectations will decrease over the years, we recommend that Rega loudspeakers be compared with the best. Rega's open, natural sound and precise stereo imaging has been achieved by the careful integration of attention to detail, quality components, and a co-ordinated subjective and quantitative development program. The result is a loudspeaker that compares favourably with the best, at a fraction of the price.

REGA SPECIFICATIONS

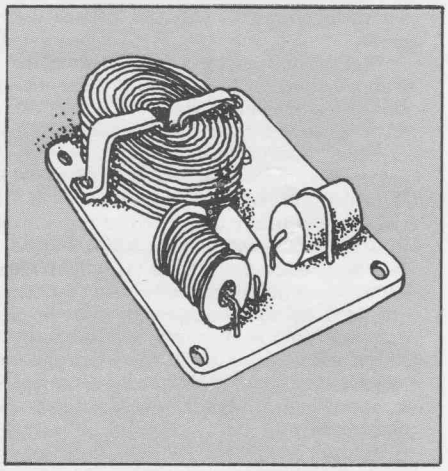
LF Unit	16.5 cm diameter, long throw unit having aluminum former for high power handling, butyl-rubber surround and treated cone for low coloration.
HF Unit	2.5 cm diameter, dome unit of soft impregnated fabric to reduce coloration at high frequencies.
Crossover Network	Consists of close tolerance air cored inductors and solid dielectric capacitors. Second order Butterworth with nominal crossover frequency of 3 KHz.
Sensitivity	87dB/watt at 1 metre.
Maximum Level	107dB at 1 metre.
Frequency Response	30 Hz - 25,000 Hz 60 Hz - 20,000 Hz ±2dB
Enclosure Type	Critically damped bass reflex.
Recommended Power	10 - 100 watts per channel.
Weight	10.5 kilograms.
Dimensions	61.0 cm high x 24.1 cm wide x 27.9 cm deep.



CABINET

The striking appearance of the Rega loudspeaker is the result of both functional design and careful craftsmanship. The proportions of a loudspeaker affect its dispersion and the outstanding stereo imaging of the Rega is partly a function of its unique, narrow, deep cabinet. The precise spacing of the drivers in a vertical array allows the Rega to approach a point-source rather than a line-source reference for more stable stereo imaging. To maximize this effect and avoid bass coupling with the floor, the Rega is meant to be placed on stands.

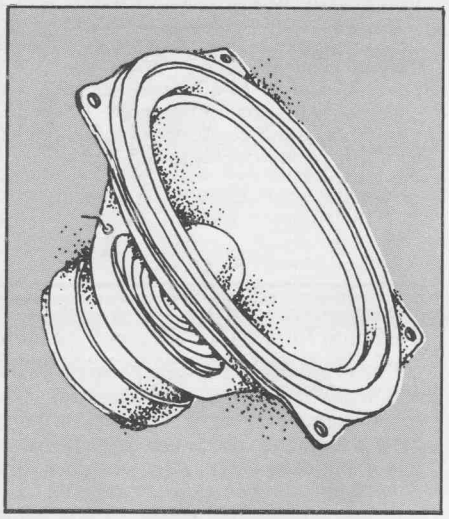
The cabinet is constructed from 20 mm high-density particle board. Optimal bass loading is by a port tuned to its 40 litre volume. Low-frequency echoing backwaves from the rear of the driver are absorbed by a layer of damping material fastened directly behind the bass/midrange unit. To reduce higher-frequency reflection, a 40 mm thick layer of damping material covers the entire rear panel. Quick-connect, colour-coded terminals are provided for secure connection to your amplifier.



CROSSOVER NETWORK

Contemporary design practice is often to choose random loudspeaker drivers for their price and then match them through an elaborate crossover. Rega also rejects this approach and prefers to use close-matching, compatible drivers that not only do away with resistors but also make a complicated crossover unnecessary. The money saved by doing without superfluous parts can then be spent in high quality components in the simple network used.

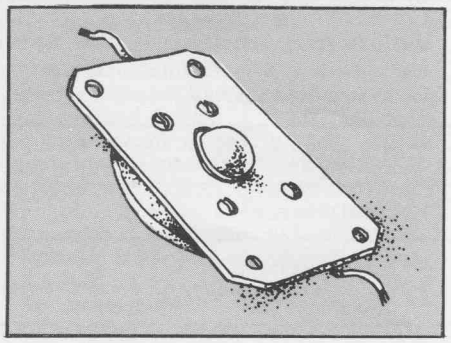
Rega also rejects the commonly used, less expensive iron-cored or ferrite-cored inductors because the value of the inductance in these components changes with current and does not remain stable. The logical alternative of using air-cored inductors is not available to most manufacturers because the large size necessary to produce the required inductance causes excessive DC resistance, which leads to power loss and poor damping of the bass driver. Rega's crossover was carefully designed to do away with excessive size while retaining the virtues of air-cored inductors – even at high power loads, distortion produced by non-linearities in inductors is avoided. For similar reasons, the more common loosely-toleranced electrolytic capacitors that change value and increase distortion were also avoided in the high-frequency network. Only closely-toleranced, expensive mylar capacitors were used to ensure linearity under dynamic loads. The result is a smooth, audibly imperceptible transition between drivers at 12 dB/octave for minimum overlap and controlled phase characteristics. The crossover point of 3 kHz ensures that both drivers are working within their optimum range.



BASS/MIDRANGE

To impress the inexperienced buyer with numbers as opposed to quality, pretentious affordable loudspeakers often use cheaper separate bass and midrange drivers. To produce deep base, a speaker cone has to move a substantial volume of air and a large separate woofer moving only a small distance is commonly used. This requires the use of a separate midrange driver, an approach Rega rejects because it entails the use of an additional distortion-inducing crossover point and introduces supplemental driver-incompatibility problems. The fundamentals of most musical instruments are found in this range and a more accurate, integrated sound is produced by the use of a single driver for bass and midrange. This is particularly important because the ear is most sensitive, and hence most critical, in the midrange. Bass is still substantial because large volumes of air can be moved to provide deep bass by using a smaller-diameter driver moving through a greater distance.

To produce a well-dispersed and uniform mid-band together with a low-distortion bass of adequate power, Rega uses a long-throw, 165 mm bass/midrange unit manufactured in France by Son Audax. A highly compliant butyl-rubber surround, a long-throw suspension, and a low-mass cone combine to produce a very fast transient response with unimpeded linear excursion at low frequencies. The cone is treated with a silicone-based compound to damp out ringing and resonances as well as reduce uncontrolled distortion-producing flexing. The voice coil uses an aluminum former rather than the more common paper and this effectively dissipates heat to allow higher power handling. This modified driver gives exceptional sensitivity, and power handling sufficient for reasonably demanding use, without excessive expenditure but with careful control of the important design parameters.



HIGH FREQUENCY UNIT

The high-frequency unit is a 25 mm diameter hemispherical dome also manufactured by Son Audax and commonly used in much more expensive loudspeakers. The dome is constructed of a soft material incorporating a treated-fabric damping layer. This ensures outstanding linearity throughout the high frequencies with an absence of resonances. The diaphragm has exceptionally low mass resulting in low distortion and excellent transient response. Like the bass/midrange unit, high power inputs can be sustained without damage by the use of an aluminum former in the voice coil. The small diameter of the dome provides an even, wide dispersion of the high frequencies and allows greater freedom in room placement.

YOUR REGA DEALER:

import audio

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