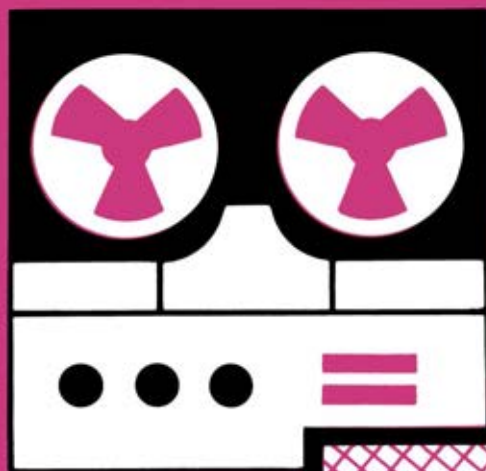


NEW HI-FI SOUND GUIDES 20p

Planning and buying Hi-Fi

3



Spending wisely on
stereo from disc
and tape

by Clement Brown editor HI-FI SOUND magazine

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Planning and buying Hi-Fi

WHAT IS HI-FI and why is its appeal so strong? How does one set about choosing equipment and ensure it is kept at peak performance? How does stereo work and what are its advantages? Will new developments affect the choice of system? Answers to such questions form the basis of these booklets. Written by Clement Brown, editor of *Hi-Fi Sound*, and closely linked with the policy of the magazine, these concise guides are of special value to the beginner but also meet the need of the more advanced amateur enthusiast for a survey of his chosen subject.

Titles to follow in this series are: *Using your Hi-Fi* and *Practical Hi-Fi Guide*. *Introduction to Hi-Fi* and *All about Stereo* have already been published.

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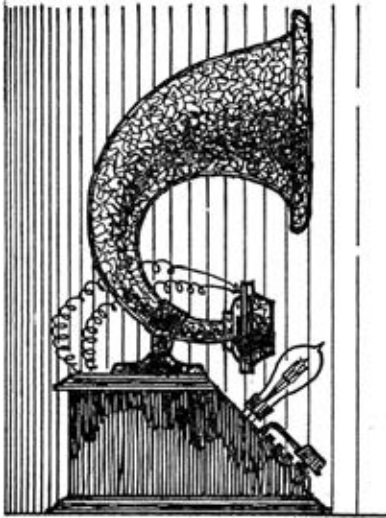


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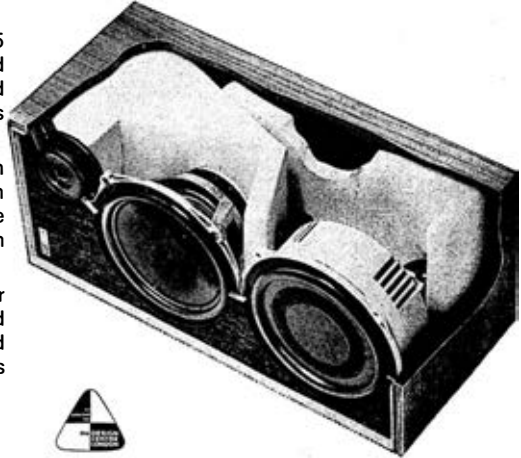
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1

ARE YOU SERIOUS ?

YOU ARE serious enough to want to study this booklet and seek advice on what may turn out to be a fairly sizeable purchase. But still the questions must be asked. Do you really want hi-fi? And are you prepared to pay for a high standard? The very considerable variety of audio equipment available will form systems ranging from under £100 to several times that sum, and it is not *a//* high fidelity.

As interest in sound increases, and as standards are pushed up and more listeners buy more costly products, a lot of cheap 'gramophone' audio is left behind. You can play records on it but it does not qualify as hi-fi in the presence of the genuine article. Cheap and cheerful products are not necessarily a bad buy—but it gets us nowhere if we misrepresent them.

It is not possible to define the high fidelity starting-point in a few words, but the underlying principles and a number of important qualifications were explained in the preceding two booklets in this series. At this stage we must persist with the question: Do you really want hi-fi? It is much the same thing as asking whether you are a serious listener for whom music in the home will become essential—a pleasure enjoyed frequently and keenly and with a critical attitude to detail and realism.

A 'serious' listener does not necessarily take his pleasure with a long face; and few sit score in hand, ready to jump on the slightest flaw. He may enjoy the classics, light music, pop—any or all of these—and his main aim in installing a hi-fi system is probably to make a high standard of music reproduction available at all times. He will want to relax in his favourite chair, immerse himself in the sound, forget other things for a while.

But this contrasts with the needs of those who require only occasional background sound or entertainment, accepting the outline of the music rather than the inner detail. Gaining a general impression and enjoying the realism of modern stereo are two very different things. High fidelity is for serious, extensive use. It may have initial novelty, of course, but the real test is its long-term musical merit. The discerning user will come to expect a great deal of his stereo system, and above all he should be able to look forward to freedom from listening fatigue! So the system should be planned and used with care.

As we go on to the basics of planning and choosing, these questions of quality—and the price to be paid for a given standard of performance—will feature prominently, and no apology is offered for the stress laid on budgeting and money matters. Care over detail is another feature. If you care about the results, you should devote special attention to the means by which you can achieve them. Obviously you will not turn yourself into a combination of engineer and music critic for the occasion, but a little study of an intricate subject will help you secure value for money and aid an understanding of the finer points.

2 ACCORDING TO PLAN

MANY PEOPLE, seeking advice on the purchase of audio, ask a question that goes something like this: 'I have £150 to spend and am anxious to obtain good value. Although my technical knowledge is about nil I know what's good when I hear it—but the amount of hi-fi is so vast that I hardly know where to start. What about Brand X and Brand Z—are they any good? Can you help me make a start?'

The questioner *is* off to a good start, for he has fixed his budget! Evidently some knowledge about current products also has been collected, however sketchily. In fact the question would be a good one if a complete system or two were proposed; at least it would indicate areas of interest and the short-list could be confirmed or criticised. Better than the plea from the non-planner who could not resist an expensive piece of electronic gadgetry which, in the absence of funds to complete a system, he placed on a shelf where he could admire it and watch it collect dust. Later he was reduced to rummaging for makeshift items—a cheap record changer, no-name speakers on special offer and other wildly inappropriate hardware, all of which consorted oddly with the initial purchase.

Planning hi-fi for the home starts with a budget. The vast array of equipment from the UK and foreign makers (a *Hi-Fi Sound* survey listed over 150 *small* loudspeakers and excluded many more) may seem bewildering to some, but variety and freedom of choice are better than shortage, and in the generous selections of components and systems there must be something to meet every need. So the first requirement is a budget. Fix this figure realistically and plan to meet it. Use common sense, read about the products, and take expert advice if necessary.

Golden rules

There are a few do's and don'ts that apply generally. All will be explained or qualified in some way as we go along but it is as well to present them now as warnings. At least a blunt word or two will be appreciated by the enthusiast who aims to be off to a quick start and has no intention of giving the subject much deep study.

- Genuine high fidelity is not very cheap. Therefore decide whether or not you *want* hi-fi.
- Fix the budget and allocate it sensibly to the various links in the chain.
- Plan the system with an eye on room size and type.
- Do not expect to hear realistic results from a low-budget, low-powered system in a large room.
- Take special care with the disc equipment. The pickup is in touch with the music.
- Don't rush your planning, listening and choosing.

Popular audio outfits start in a kind of hi-fi fringe area—or mid-fi, if you can accept such a term—in which at least a few basic features of established hi-fi practice can be recognised (separate speakers, amplifier of above-average quality and so forth). A carefully chosen and adjusted outfit at well under £100 can sound quite pleasant in a small room—better than the old-style stereogram, which is a misfit in any surroundings.

From this low-budget area we move up into the medium region which, it is reasonable to say, extends to around £250. Here the variety is very great, whether you buy separate units and form a system (still the best approach)

or settle for a complete, housed and 'matched' outfit from one supplier. After that, if you are fortunate enough to have a practically unrestricted budget, there is the possibility of assembling a generously rated, no-compromise system at up to £500 or even more. This is not necessarily a matter of ostentation: you can spend such a large sum easily and obtain good value, rejecting gimmicks and, indeed, everything that does not contribute to the sound.

Examination of the superior performance from advanced units and components (say £60 for a cartridge, £150 for each speaker) will show that the outlay brings results. It is true, though, that in the higher reaches one is spending relatively large amounts on more subtle features. The music-loving enthusiast, already thinking of allocating £100 for a loudspeaker, may easily decide to spend more if he is convinced of the gain in musical terms.

Returning to the more modest budget levels of interest to the majority of readers we can highlight the next stage of planning by showing how much of the budget is claimed by each part of the system. Experience shows that at the £100 'budget stereo' level the division is roughly: 25% for the player (including cartridge), 45% for the pair of loudspeakers and 30% for the amplifier, assuming normal retail prices. There might be specially favourable purchases, or opportunities to save by means of some do-it-yourself work, that would lead to some adjustment. Otherwise any *big* shift in this balance would probably result in disaster. Note that the above covers a simple player with cheap magnetic cartridge, an amplifier rated at 8 to 10 watts per channel, and a pair of bookshelf speakers—a compact system for a small room.

As the budget is raised, this guide to component cost may have to be revised. At the £150 level it is possible that the speakers, the amplifier and the player would each claim about a third of the total, although for some rooms it would certainly be better to allow a little more for speakers and make small adjustments elsewhere.

With still higher expenditure it is difficult to offer any concise guide, though one feature of many good systems is the high proportion of the outlay devoted to disc equipment. A typical example for a fairly large room is: £150 for the transcription unit and pickup, £90 for the amplifier becomes a about £150-180 for the free-standing speakers. The £90 amplifier becomes a £160 tuner-amplifier if FM radio is required at the time of installation; otherwise a tuner can be added at any time, as is the case with all systems. At practically all levels the addition of a tape record/replay unit involves an extra £75-100 for a passable stereo machine—but double that figure for a semi-professional unit.

Programme sources

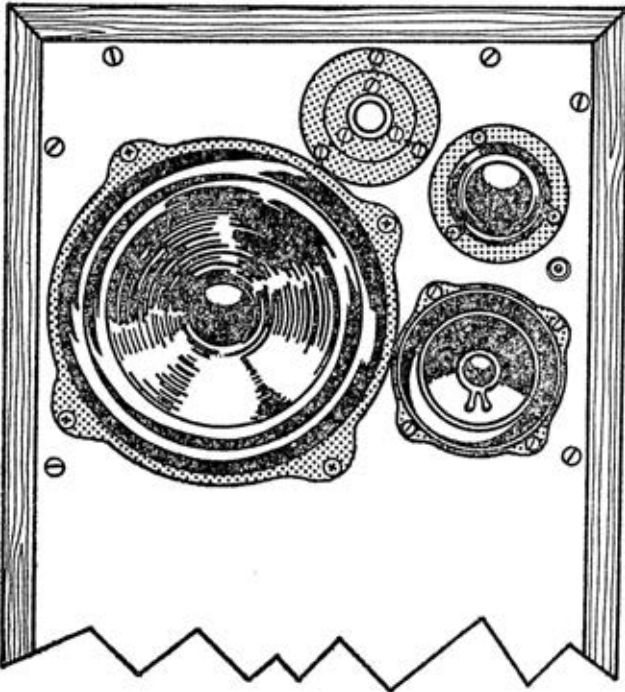
If one of the first jobs is to look at the budget and what it will buy, it is also necessary to decide at the same time which sources of programmes will be used. Most systems will accept all the main sources—radio, tape, disc—but the starting budget may not cover all the equipment. Without doubt, radio is the cheapest source. The addition of a stereo/mono tuner does not involve prohibitive cost or complication, and a combined tuner-amplifier (that is, a hi-fi receiver) is a convenient solution if FM is required at the outset.

However, most hi-fi systems are purchased because it is required to play records. The owners want to play their own choice of music and are aware of the immense variety offered in the disc format. Practically all systems cater for discs but have facilities that will permit reasonably quick, simple addition of other sources—first a radio tuner and later, perhaps, a tape unit.

Active audio enthusiasts often revive the old tape versus disc argument. It is of scant interest to the rather inactive music-lover who wishes only to have an extensive musical repertoire to enjoy. Discs have always served his interests and they continue to do so, although the noticeable improvement of music cassettes tends to influence the argument and, presumably, will do this more strongly in the future. What we have to remember is that tape appeals to the man with wider interests, particularly the creative enthusiast who intends to make full use of the medium. Tape is for recording as well as listening. Nowadays this is true of cassettes as well as open-spool tape, especially with the Dolby system to make the best of restricted performance at low tape speeds, though at present a cassette recorded on a £120 unit cannot usually compare with a tape recorded on an open-spool machine costing the same amount.

If present trends are seen through to their anticipated conclusion, magnetic recording in cassette or other compact form will feature in more audio systems in the future. Even with the application of noise-reduction systems it seems doubtful that open-spool tape will become much more prominent in hi-fi systems. Tape enthusiasts are correct when they assert that tape can yield superior results, but the newcomer should consider the factors of cost and complication.

Expensive machines used at high tape speeds are needed to surpass the results obtained with the best discs played via high fidelity systems. It is usually found that amateur enthusiasts who question this have no experience of disc replay of very high quality. Tape machines involve a mechanical complexity that has no counterpart in disc replay. And further, it is generally found that distortion levels with domestic tape machines are worse than



Arrangement of drive units in a high-grade speaker system. Establishing relative positions is an important feature of design.

those achieved with discs (the same is very often true of signal-to-noise ratios). Certain details, notably the limited life and high replacement cost of tape heads, are carefully ignored when tape v. disc arguments arise. In short, high quality tape recording and replay—the medium that enables hi-fi to start in the recording studio—will attract the enthusiast who is prepared to take a professional interest in audio. The results will be far from ideal if he tries to pursue his interest very fully while making economies.

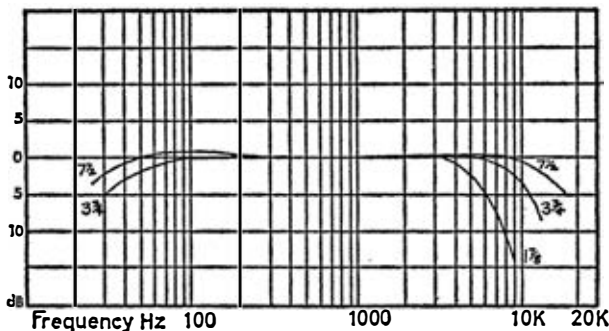
Taking shape

Those who have already looked at modern hi-fi stereo will have observed the shapes, sizes and styles of presentation. For many people these questions of appearance, allied to function, will be important since they influence convenience in use. The user will want to consider whether stereo can fit into the room without more ado; or whether some special provision has to be made—for instance, the addition of shelves or the rearrangement of existing furniture.

A very large proportion of high-grade audio equipment is in 'unit' form. Each unit is a functional item—an amplifier in a case or wood sleeve, a player on a plinth with a dust cover, a tape unit also on a wood base, a pair of speakers to be positioned for best effect. Hi-fi design of this sort was influenced by purchase tax as well as by certain technical and practical factors, and unit design has stayed with us, spreading to all price levels including that favoured by large radio organisations whose systems, not usually claimed to be hi-fi, are really stereograms in 'audio separates' form.

The purchaser of audio units links them as required, or asks his supplier to do this, and he does of course have to cope with the matter of appearance if his purchases are made by different manufacturers. There are fewer problems of visual design now that more firms make matching ranges of equipment, buying in items (such as turntables) that they do not themselves manufacture and housing these so that there will be a styling match throughout the system. Units can stand on shelves or wall furniture (bookshelf speakers seem rarely to stand on bookshelves) and to some extent it is possible to use existing cupboards or furniture—subject to any special ventilation requirements or problems of acoustic separation of the components.

Exactly the same in principle are the matching ranges of units marketed by a few large manufacturers. The difference is that special emphasis is placed on the styling of the equipment; and to some extent the non-technical customer is relieved of a planning task since the units are planned in groups, the manufacturer making it clear that, say, a specific amplifier or receiver is intended for use with particular loudspeakers and other ancillary items. This



Record to replay response for three speeds of an expensive mono portable tape recorder.

is very much a 'plug-in-and-play' approach: the purchaser has little if anything to do apart from placing the units in position on shelves, etc.

At one time all hi-fi was in units form, and with a restricted choice and a number of specialist firms doing work in which they were skilled—too often in isolation from other firms' efforts—the visual aspect presented some hazards. These problems have all but disappeared as variety has increased. To add to the choice presented to the customer there are now a number of housed systems in which the speakers are separate but everything else is in a console or low-styled cabinet, the latter offering record-storage space or a compartment for a tape recorder. For the hi-fi user who prefers the 'furniture look' there are purpose-built equipment cabinets that will accept various combinations of popular audio units; and a few cabinet-makers with special knowledge of the hi-fi market will construct cabinets to meet individual needs.

Scope for DIY

References to budgets are in the main based on current retail prices. However, most people appreciate an opportunity to make a saving, and the man with a practical flair is most favourably placed to practise economy. The hobbyist and constructor will, at the planning stage, decide how his talents can be employed to good effect. The aim should be to save money on features that will not adversely affect the sound quality; or the prospect of securing a higher standard for a given outlay may instead prove attractive.

Given sufficient familiarity with circuits and components, and the ability to translate a paper design into working equipment, enthusiasts can make substantial savings on amplifiers, tuners and the recording and replay section needed for use with a tape deck. For audio designs, consult the publications issued from time to time by electronic components manufacturers such as Mullard and Ferranti. Sometimes a fairly deep knowledge of electronics theory and practice is necessary to ensure success, and the amateur should not start this kind of project unless he is confident that he can carry it through.

A well prepared and documented kit is another matter entirely. Kit amplifiers (Heathkits are the best known) can be assembled by amateur enthusiasts who lack technical knowledge. The main requirements are soldering ability (practice should develop this simple skill), a few tools, and a determination to follow clearly written instructions in every detail. With most kits the result of the work is a piece of equipment that is substantially the same as a manufactured version. Tuners, tuner-amplifiers, speaker systems and other items are available. At present there do not appear to be any tape recorder kits of high fidelity calibre.

Needless to say, the saving made with an electronic kit is not so great as that secured through construction with a circuit diagram and a boxful of bits and pieces. The kit manufacturer prepares the work and provides backing services; the enthusiast who works from a circuit is very much on his own.

While many inexperienced but keen enthusiasts would think twice before attempting electronics work of any kind, there are thousands of amateur woodworkers who consider that loudspeaker construction is quite simple. It is indeed possible to make satisfactory loudspeaker systems, in some cases the counterparts of factory-made models, provided approved and tested designs are employed. The amateur should not experiment on the basis of insufficient knowledge—hi-fi speakers are not *that* simple.

There are three main approaches. The first is the speaker system kit (e.g. Heathkit), complete in every detail. A kit involves little effort—mainly the

fixing of drive units, a small amount of wiring, and minimal attention to the enclosure supplied. The second route to a successful speaker is the drive unit kit, which leaves the amateur with the work he is best qualified to complete—the enclosure.

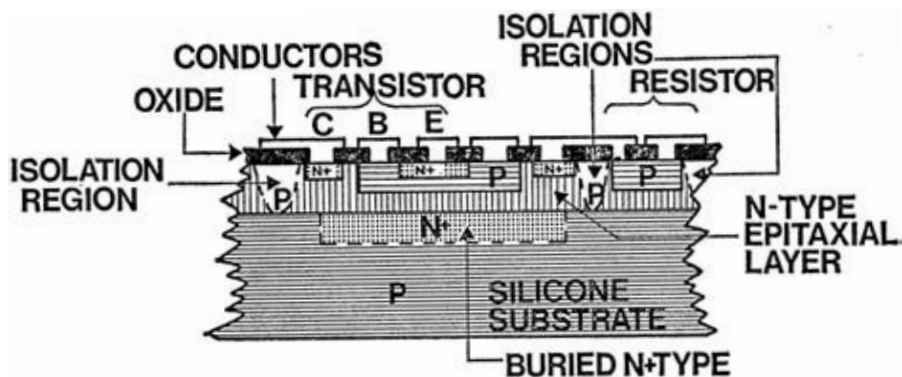
Finally there is the more basic method that has been favoured by enthusiasts since hi-fi became a word to conjure with. The leading manufacturers make their drive units available separately, together with semi-technical literature (usually free) to aid the constructor. The literature makes interesting reading—it is instructive on such topics as acoustics, crossover filters and choice of materials—and provides enclosure dimensions and other data. Manufacturers noted for technical services include Celestion, EMI, Goodmans, KEF, Lowther, Peerless, Richard Allan, Tannoy and Wharfedale.

It should go without saying that the handyman who constructs speakers can also make a plinth for a player, and shelves or furniture for the hi-fi units. Potential savings on these items are considerable.

Who makes what?

Newcomers to hi-fi often comment on the vast amounts of foreign equipment in the showrooms—a variety that is reflected in the advertisements in magazines. Why not buy British, they ask. And is the foreign gear any good? Of course, there are well established hi-fi names in the UK, and there is no problem in assembling a system from all-British units and components. In this country we are particularly good at making high-grade loudspeakers, though other audio departments are less well represented (pickup cartridges are at the bottom of the list—that is, in respect of choice).

However, there is brisk international trade in audio and radio electronics, and the huge Japanese electronics industry sends us a great variety of equipment, much of it technically advanced and reasonably priced. In the UK we are able to choose from tape machines and complete systems from Scandinavian countries; audio electronics, tape equipment, microphones and some beautifully made auto turntables from Germany; cartridges, microphones and headphones from the USA; turntables and other items from Switzerland; and equipment in every category from Japan.



Cross-section of integrated circuit. An ic of this kind, comprising a number of transistors and other elements, could replace a section of conventional circuitry in an amplifier or tuner.

Which is best?

Convinced of the merits of hi-fi stereo but daunted by the sheer numbers of competing products, the enthusiast-in-the-making may feel like asking the experts that most difficult of all questions: 'Which is best?' And the experts will feel like replying with some more questions: Best for what? Best for how much? Best in which category and for use with which other equipment?

The expert, in a position to test, inspect and compare many products, may have his own ideas about outstanding items. He could even reply to his tormentors: 'The ABC Mk2 cartridge is best because I say so. Go and buy it.' Or: 'I have never heard a better speaker than the Bloggs Super Re-entrant Reflex. Do hear it soon.'

The newly hatched enthusiast would go off in search of these items. He might find that the ABC cartridge cost too much or that he could not afford the arm required to make it work properly. Or the Bloggs Super might be the first really big speaker he had ever seen: a pair of Bloggs might be nearly as big as his room—and quite possibly he would not like the sound of the things anyway.

High fidelity is a fascinating but intricate subject. Choice of products depends on many things—budget, personal tastes and prejudices, size of room, special requirements to do with operation and convenience in use, and much else besides. It is simply not reasonable to expect a stranger to choose your hi-fi system for you.

This is not to say that the experts cannot communicate any information on good, bad and in-between products. It is possible to measure performance and present test results in a way that will enable the customer to check the merits of products in particular categories—units in a given price-range, for instance—and determine whether these products are likely to give satisfaction. In fact the technical work done on behalf of consumers can speed the task of short-listing possible purchases. Those about to spend large sums on complex equipment should take seriously any objective reports on products that interest them. After that the decision is theirs: they should go on to hear some hi-fi and reach a conclusion about which is best.

3

CHECKING THE FACTS—I

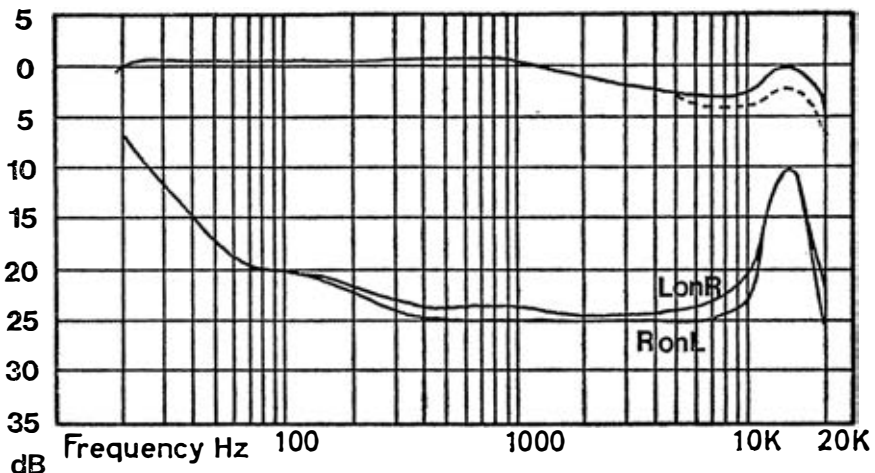
THESE CHAPTERS are about published facts and figures. They are not very much concerned with opinions about hi-fi equipment, still less with judgments of hi-fi sound quality. After all, you may, after a little reading and listening, conclude that the pundit's opinion is as good as yours—no more, no less. He knows what he likes, and so do you. Indeed, there is usually a surfeit of opinion on sound quality—plenty of subjective assessment.

Many people start being objective about high fidelity when they arm themselves with stacks of manufacturers' literature. Some of this is very informative, and the prospective customer will be able to gain a few ideas about practical features and details of performance. These will to some extent influence him as he short-lists the equipment that seems to meet his requirements and falls within his budget limits.

However, it is every magazine editor's experience that potential hi-fi enthusiasts are an inquiring, even sceptical breed. They respect the reasonable and restrained claims made by a reputable manufacturer, but they do not necessarily believe all the performance data printed in a sales leaflet—any more than they believe everything they read in the newspapers. Very naturally they like to see test figures published by independent experts, and for such test reports they turn to a specialist magazine.

Test figures

In doing so they are able to read—for a very low fee, despite rising magazine production costs—the findings of an expert tester or consultant who is not only knowledgeable in the audio field but is also well equipped to undertake tests employing the latest measuring methods. (It has been found in some instances that *Hi-Fi Sound* methods have been ahead of those known to the manufacturer; and there have been cases where the independent test



Frequency response (left and right channels) and channel separation of a high-grade moving-magnet cartridge, measured after optimum tracking was established. Load 47kohms.

work has influenced the design of equipment.) Admittedly some of the consultant's opinions may be mixed with the science, but the main thing is the presentation of the figures.

Does the amplifier deliver the claimed output power? Does the speaker really go down to 30Hz? Does the cartridge track at 1gm. in a suitable arm? The published test results may or may not confirm the manufacturer's claims—and that is where the subject becomes most interesting for the man who is about to spend his money on hi-fi. Some wary folk do not reach for their cheque books until they have read test reports on the products that attract them.

Not surprisingly, the service offered tends to be of a technical sort, but attempts are made to interpret test findings. Objections to technical reporting were mentioned in the first booklet in this series, where it was pointed out that, with a little effort, most technical discussions can be related to musical results. The technical side is there for a purpose, and the expert cannot usefully report on an essentially scientific product without testing all or most details of performance.

As was also mentioned—as a warning—some commentators have been known to suggest that, since the sound is all that matters, the technicalities cannot influence the customer. When one hears this kind of remark it is time to question motives. A remarkably wide variety of technical shortcomings could, to the inexperienced, seem very minor matters in the face of an assurance that the sound is out of this world! The sound *does* matter, and the decision to buy should rest finally on what the system sounds like; but the average customer investing in some rather intricate electronics and mechanical engineering needs further guidance on the standard reached.

The various technical points encountered in manufacturers' specifications were explained in the first booklet, *Introduction to Hi-Fi*, and some of these came in for further discussion in the second booklet, *All about Stereo*. These same parameters claim the tester's attention and will be found in published test reports. The following comments, intended as an introduction to test reports rather than an exhaustive criticism, may encourage the new enthusiast to take an interest in audio facts and figures. However, do remember that it is unwise to isolate a test figure and make much of it. Testing throws up a selection of interconnected factors, and these have to be taken one with another to learn whether the product is acceptable.

Pickups

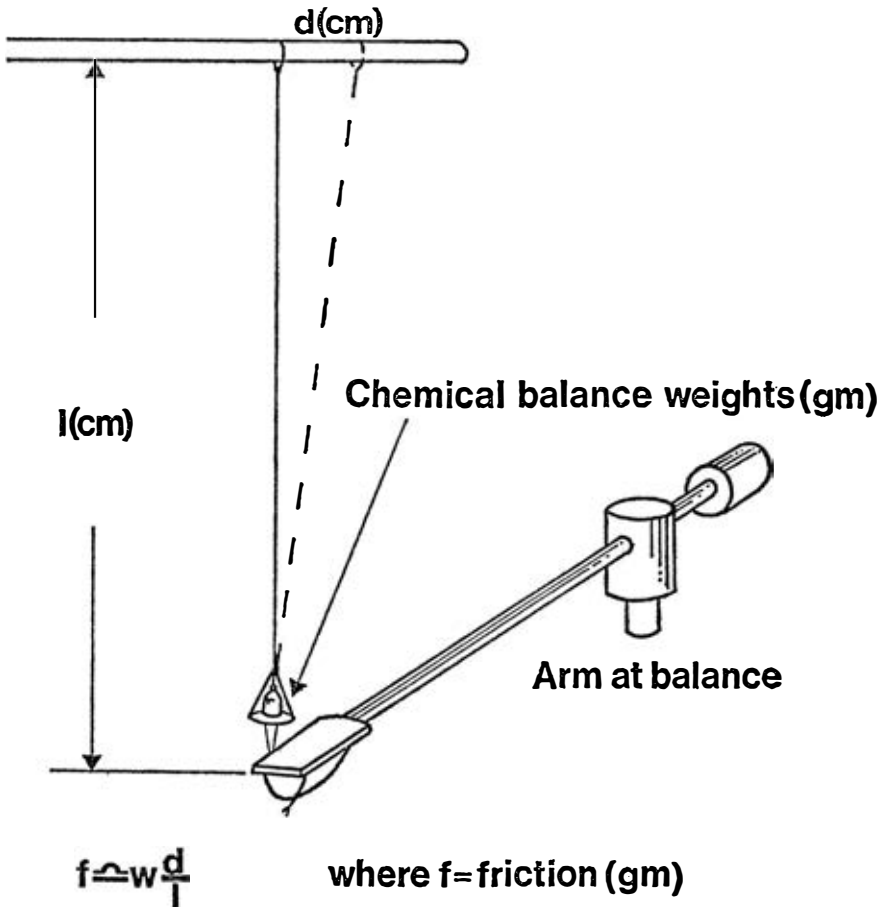
What, then, do you learn from a test report on a pickup? Apart from a very few complete pickups (complementary head and arm), a pickup takes the form of a cartridge fixed in the headshell of an arm, and the enthusiast about



Left: Tone-burst test on medium-priced magnetic cartridge. Oscillogram shows marked 'ringing' up to high frequencies. Right: Ringing effect due to resonances in cheap magnetic.

to buy equipment will study reports on the separate components. He will anticipate fitting one to the other: so the first thing he expects to find is some information that bears on the use of the cartridge in typical arms, or on the likelihood of the arm accepting certain cartridges. Several interesting points may come to light in a thoughtfully prepared report. For instance, the cartridge may be really satisfactory only in a specially damped arm; or the weight of the cartridge may limit its acceptance—the use of low-mass cartridges in low-inertia arms is a modern trend.

You will want to know a cartridge's output and frequency response, and sure enough—there they are in the test report. But something else must be checked first: the optimum tracking weight on realistic levels of recorded modulation must be established. This really *is* the first thing to look for, apart from any purely mechanical points about setting-up. The properties of cartridges have been known to vary with alteration of tracking weight, so what on earth is the point of fidgeting about response and so forth until

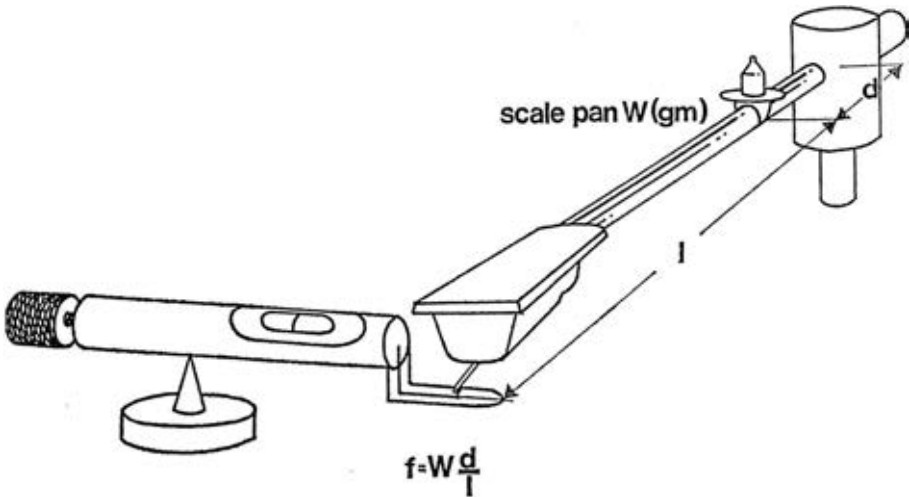


Method of estimating lateral arm pivot friction with the arm balanced out. The thread is moved along the beam and its displacement from vertical is measured when the arm is just moved by the force applied. Resistance to lateral motion (i.e. starting friction) is calculated from thread length, the weight and the displacement.

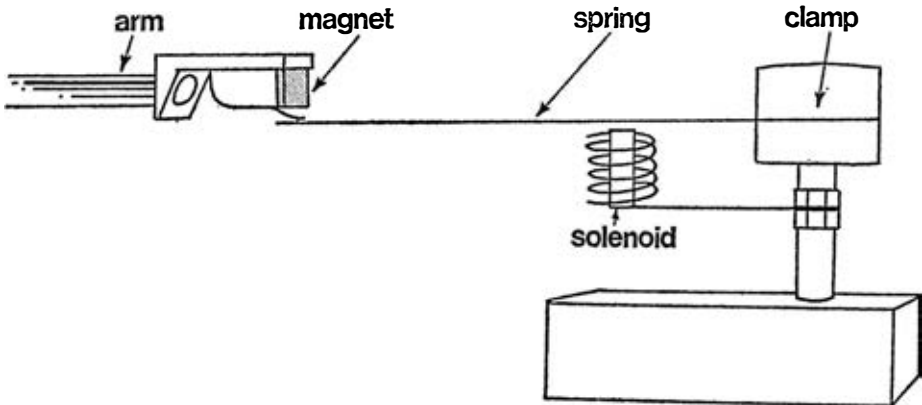
the tracking ability has been studied? Optimum tracking will most likely be within the manufacturer's recommended range, assuming that bias correction has been carefully arranged; and normally it is found that further increases in tracking weight produce no audible improvement in tracking ability.

So, if you are thinking of buying a modern super-light tracker you will look for the details of tracking tests. At this stage the tester may report that he did some preliminary listening (he could hardly do that without knowing about the tracking ability and setting-up the cartridge properly) in order to gain some impressions of relevance to the investigation. Then he will go on to the technical bits, including frequency response and crosstalk.

The majority of pickup specifications mention only a frequency range (without dB limits), so the response measurements may turn out to be quite interesting. One good cartridge may have a very flat-looking response and



Measuring vertical friction. W is the scale-pan weight, l the stylus-to-pivot distance, and d the distance from pivot to scale-pan weight.



Measuring the effective mass of a pickup.

another may not. Sometimes there is a treble peak or a droop, or even a trough ('suck-out'), and only a graphical display of results can give you a clear indication of the actual shape of the characteristic, which you can consider along with other findings. If the response curve is a mess and other measurements do not yield very encouraging results, you may well feel uneasy about the product—unless, perhaps, it is cheap and the shortcomings are not too bad at the price.

On the other hand, an expensive cartridge might have a kinky response curve, low distortion and brilliant tracking performance, and this combination might not be too worrying if the response kinks were such that tone control adjustment could compensate. A cartridge that droops *a little* from 1kHz, unpromising as that may seem, may be a good candidate for correction by means of a touch of treble lift at the amplifier. Channel separation (or crosstalk) comes in at this point and rarely offers any great problem, although the tester should comment if there is anything odd such as unusually good or bad separation at the extremes of the range.

Output is measured. Compare it with the claimed figure for a specified recording velocity (mV per cm/sec). Measurements of distortion and vertical tracking angle (see *All about Stereo*) are attempted by some testers and, although such tests are far from easy to do, the reported account of the work produces interesting sidelights on pickup design and behaviour. Then in some of the more advanced reports there are the results of investigating transient response using special test discs (tone bursts, particularly); comments on the probable effective tipmass; and notes on the behaviour of the compliant pivot in the stylus assembly.

Subjective testing is usually discussed again at the end of the report. Some commentators offer little of this, perhaps feeling that they may be misunderstood or that their work ends with the completion of purely technical tests. However, it should be possible to provide guidance on what the device sounds like on a range of recorded material; this is not really the expression of an opinion but rather a matter of relating the sound to the measured performance where this is possible. There is of course the problem of finding the right words and avoiding ambiguities. If it is done, it can help guide the customer towards the type of component he is likely to find acceptable. But the customer should find opportunities to hear cartridges: in fact there is much to be said for listening to pickups as carefully as one listens to speakers.

Pickup arms

As for hi-fi pickup arms, so few in number, the reader could do worse than study the test reports for evidence that arms contribute nothing to the general sound quality. The arm may not actually reach this ideal, but the enthusiast can at least feel confident about his purchase if it is clear that the discrepancies are slight. The arm's job is to carry a cartridge, providing it with the right conditions so that it can perform as intended.

Most important: check that the arm accepts most popular cartridges (if it is a universal headshell type), that the pivot frictions are slight enough to permit satisfactory working at the relevant tracking weights, that the bias correction facility is adequate, and that the range of adjustment (height, lift control, etc) is appropriate to the conditions of use. Relate this adjustment range to the type of turntable to be used, if the components are separate. Some adjustment is still required if the arm is mounted on a turntable, especially that enabling the arm tube to be set parallel to the record surface when the cartridge is mounted (but this, alas, will not be possible with some automatic players).

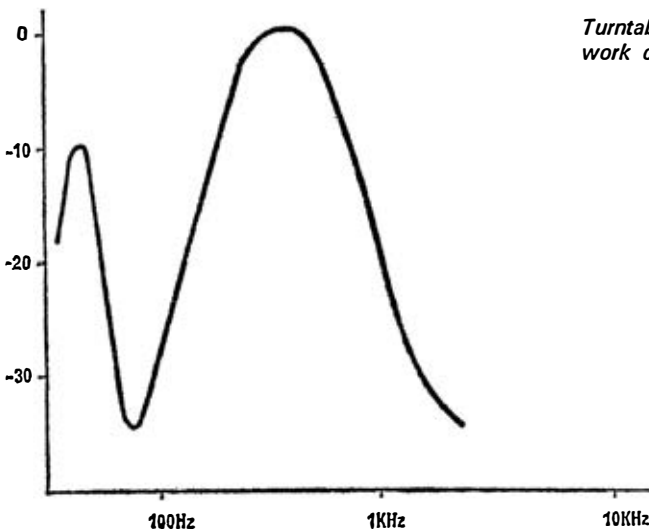
Look for comments on features that may restrict the use of the arm, and check on the provision of connecting cables and accessories. It is worth emphasising that in many instances the manufacturer's specifications tell the purchaser little that is useful about an arm's suitability for use with other equipment; so there is no real opportunity here to compare the claims with the measurements—but all the more reason to read the report to learn something about the real merits of the product!

Turntables

With turntables again it is true to say that you have to read published critical comments to learn anything that is worth knowing about the product—and again this is because most manufacturers' specifications do not contain much meat (plenty of trimmings, though). Another important point concerns the lack of generally agreed methods of measuring 'performance'—which in this case is best regarded as deviation from the ideal state of no intrusive noises and no disturbances of constant rotational speed.

The importance of a turntable of the 'transcription' type in high fidelity systems was stressed earlier in this series. All turntables generate a little noise and exhibit some slight amount of speed fluctuation, but transcription types are better than the rest—and they cost more. The real measure of a turntable's worth is what we can term 'annoyance value': if there is some rumble, for instance, is it intrusive enough to annoy in a given system? Most surely there is a world of difference between reproduction in which there is no detectable interference with quiet, well detailed passages in the music, and that in which a low but irritating background sound intrudes to the detriment of dynamic range. Rumble is like toothache: it throbs away and prevents concentration.

We must remember, whatever the claims made for the turntable's excellence, that its annoyance value will depend ultimately on factors arising in the user's installation—outside the control of the manufacturer and only guessed at by the expert who prepares the test report. A turntable will generate some slight rumble noise that gets through in the reproduction from one system,



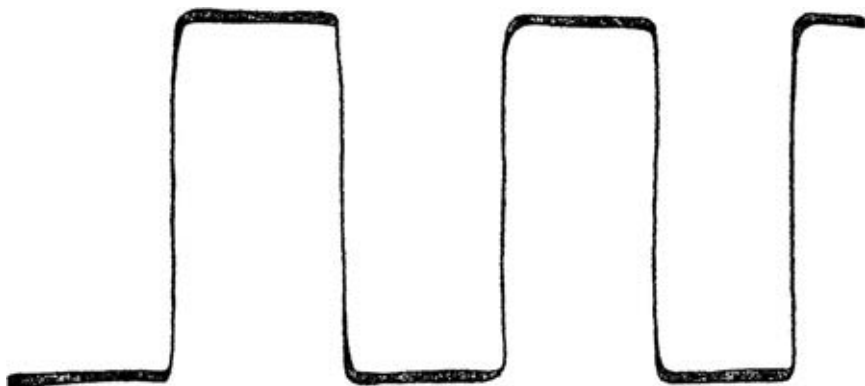
Turntable rumble weighting network characteristic—see text.

while this same unit may seem silent when incorporated in another system. It may be that the speakers in one system—room effects, too—tend to emphasise the part of the range where this low-frequency rumble peaks up. The other system's response may start rolling off at a somewhat higher frequency. The details of mounting (turntable with pickup in plinth or cabinet) also affect results, and some alterations or experiment in this direction can change one's ideas about annoyance value.

In view of such qualifications you may wonder whether it is possible to learn anything about a turntable before you buy it. However, the more informative test reports do cover rumble, wow and flutter, etc, and if we peg away at it, using respectable methods of measurement, you should find an opportunity or two to compare products and learn how much better one is than another.

A typical test report discusses construction, operational features and other, mainly mechanical matters, then goes on to quote measured rumble figures. The rumble is given in dB below a reference level (which is on a test disc), yielding an unweighted figure (such as -45dB) which reflects total noise but gives no indication of annoyance value. There may also be a weighted figure that reflects the practical—that is, aural—annoyance level of the rumble components generated. In a method used by *Hi-Fi Sound*, frequencies in the hundreds of Hz region retain their usual intensity but the lower bass range is attenuated, rising again down in the sub-sonic region where interferences such as coincidences of pickup, speaker and room resonances may also occur.

By such means we obtain some solid information that at least permits comparisons between units. It is important to understand that the test report figures may or may not bear some relation to manufacturers' specifications, which in some cases will be based on different methods of measurement. Then there are the wow and flutter figures (the smaller the better), and indications of hum radiation which can be as annoying as rumble (and certainly will be if a poorly shielded cartridge picks up substantial radiation). Again it is not possible to be precise about the annoyance value of all this to



Square wave produced across the resistive test load of an amplifier. The display reveals hardly any rounding of the leading corners, indicating good amplifier power response. Flat tops and bottoms show there is no ringing or overshoot.

the user; but obviously, the better the hi-fi system is intended to be, the better the turntable must be in every respect.

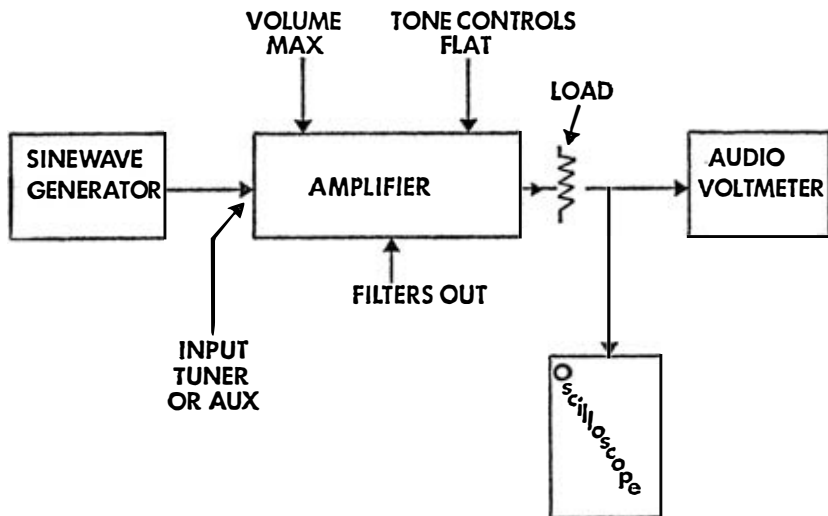
A few other points may arise in test reports. Comments on general robustness and the likelihood of long-term dependability are useful, of course, but such sidelights as the measured time taken for the turntable platter to come to rest from nominal speed have little to do with practical affairs; and even discussions of turntable weight, although tending to show that the product is solid rather than tinny, do not necessarily convey anything positive about performance. The customer can be left to check on such plus-points as speed-adjusting gadgets—electronic or otherwise—and decide whether he wants to spend more on these or whether he will be content—as many users are—with fixed speeds that are dependably on their nominal values within some very small margin.

These notes do of course apply to both integrated record-player units and separate turntables. The same considerations apply to automatic players, but in reports on these the reader expects to find an account of the modes of auto operation and their suitability for hi-fi purposes. A few of the costlier auto players have most of the attributes of a transcription unit while also providing automatic pickup control and optional record-changing. In all cases check such practical points as dimensions and clearances.

Amplifiers

The enthusiast studying a test report on an amplifier will check a selection of test results which can compare with the manufacturer's claims, bearing in mind that small discrepancies can arise due to methods of measurement and that a specification can have upper and lower limits of tolerance without being fraudulent. Of course, where there is some startling departure from the published specification the tester will have investigated possible faults and decided whether the trouble is peculiar to his sample. Small faults in electronic equipment, seemingly subtle, may have large effects on performance.

A test-bench job on an amplifier involves a considerable number of measurements, and therefore a comprehensive report may seem complicated.



Test set-up for amplifier power tests and other investigations.

However, that is as it should be if everyone's interests are to be served. The following notes on the main points will aid the newcomer as he returns to his study of reported test findings on products he may wish to buy. Comments on styling, teak cabinets, plugs and sockets can be taken as read, and we can go on to the technical bits.

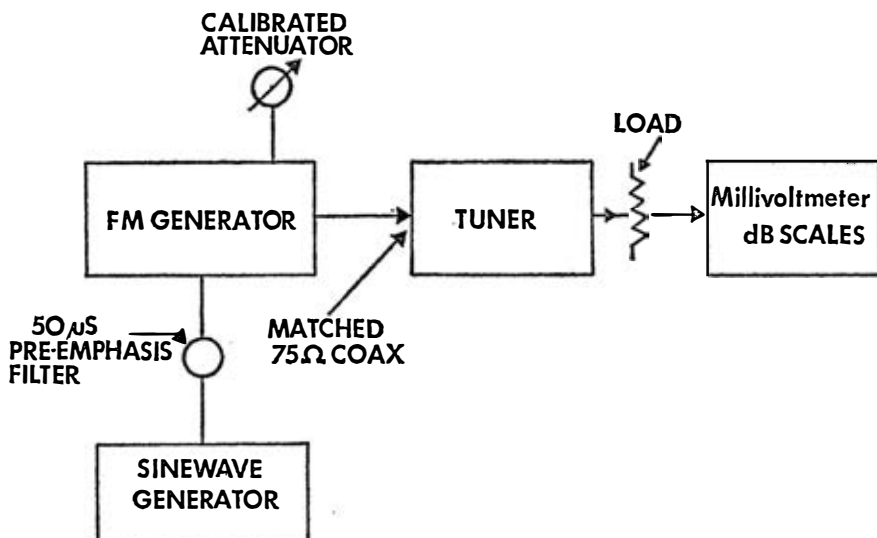
Power delivery is the first and biggest spec point to be checked—with good reason, for everyone will be interested in how much power is offered for the price. There are other important matters, of course, but once the buyer sees the power results in their proper context he is well on the way to deciding whether a particular product has the edge over another. Small differences in rating are unlikely to influence choice, but there may come the time when one manufacturer offers 50% more power than another for about the same price (indeed, it has been known).

Power ratings. The inevitable question of what power ratings *mean* was dealt with earlier but deserves further comment here in connection with test methods. Although the audio amateur may have gained a contrary impression, there is only one kind of electrical watt. How many of these the amplifier delivers depends on the method of measurement; and ingenuity with methods has yielded such ratings as 'music power', and power based on peak voltages or for limited periods, as well as ratings linked to unrealistic load conditions. Presumably a 'test' set-up that wanders far enough into the realms of fantasy will constitute an offence under the Trades Descriptions Act!

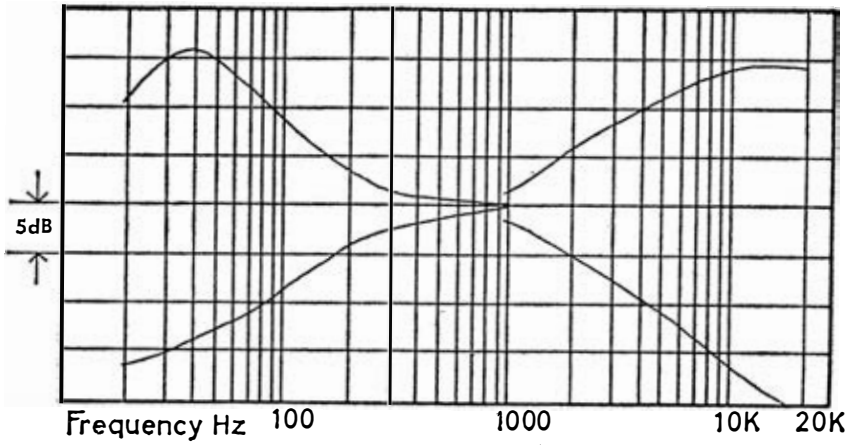
So the answer to the question 'What's a watt?' is: $\frac{V^2}{R}$ or, if you like, VI . In

rather more words, the power in watts (W) is equal to the square of the rms (root mean square) voltage across the load divided by the value of the load in ohms. It is also rms voltage multiplied by the rms current through the load. Under basic test conditions the load is a resistance able to dissipate the full power likely to be delivered by the amplifier.

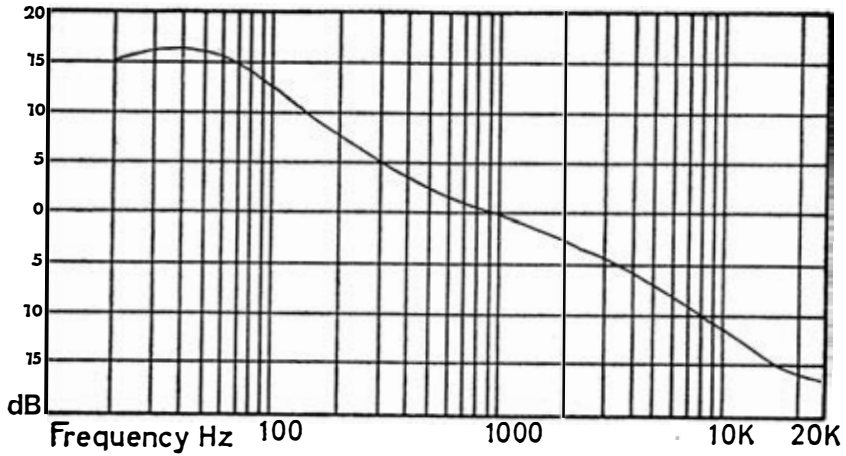
The elementary electrical theory need not detain us, and the customer will only be interested in a clear statement of the power rating and an equally



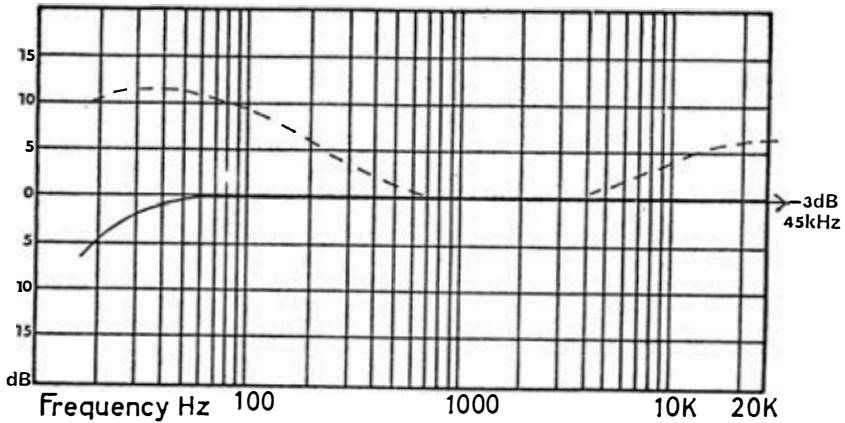
Test set-up for tuner frequency response and other investigations.



Typical spread of tone control response in a high fidelity amplifier.



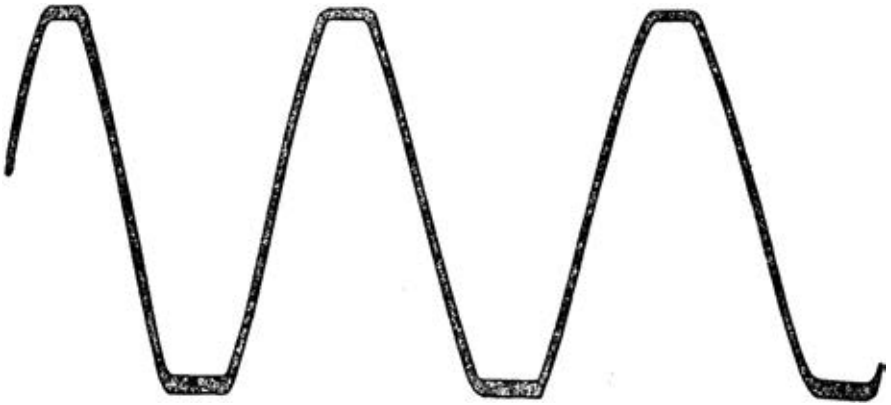
Typical response of input circuit providing RIAA equalisation for pickup.



clear test report on how many watts were delivered when a specific method of measurement was used. In the UK we measure and quote the rms-based power, the test signal being a continuous sine wave. Thus the report may refer to 'continuous rating' or 'continuous sine-wave power' or 'rms-based power'.

The fact that we do not sit down and listen to continuous sine waves has nothing to do with it: the use of such a laboratory method gives a clear indication of how many watts can be squeezed out of the product and enables a number of products to be compared. In practice the amplifier is driven up to the point where waveform clipping (serious distortion) is about to take place—this is indicated on an oscilloscope—and a watch is kept for any untoward effects that may arise. The power is measured at specified frequencies and into a specific load (8 ohms, usually) and the tester comments on whether one or both channels were driven (with both driven simultaneously the power delivery normally falls a small amount). The whole set-up gives a straightforward, honest picture rather than a flattering one.

In general, transistor amplifiers yield more power as the load value is



Showing how peaks of sine-wave are clipped when power amplifier exceeds its capacity.

Severe peak clipping of music due to input overload (left).

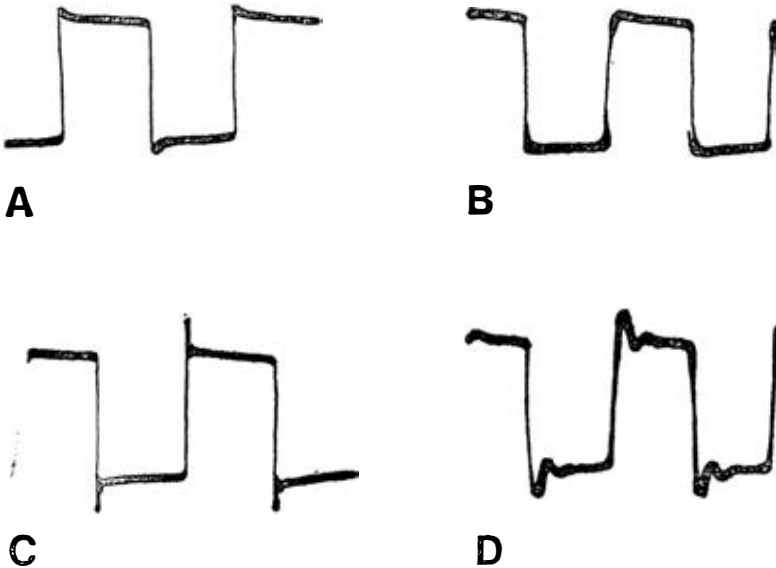
Amplifier frequency response (opposite). Broken line shows loudness control effect.

reduced. Although the test load is usually 8 ohms and most loudspeakers are of that value, the amplifier manufacturer may indicate that the model is suited to use with 4-ohm speakers. In that event the output available into this lower impedance is likely to be significantly higher than for 8 ohms; and there is a further difference between 8-ohm and 16-ohm powers. However, speaker impedance has nothing to do with sound quality.

As for the other power-measurement methods, an exploration of, say, IHF music power is of little more than academic interest. This is, because, currently, the specifications of amplifiers of any merit quote continuous ratings in addition to any 'music power' figures (which tell you that more instantaneous power than continuous sine-wave power can be delivered). This is true of some excellent Japanese and American products. If the test-report author is interested in music power he will explain why.

We should note, however, that there is no simple continuous/music relationship. It should not go unnoticed that a few cheap amplifiers are publicised with music-power figures only, the genuine sine-wave ratings being so low that they would look ridiculous in print; and we should note, too, that the most unrealistic and suspect combination of figures is a music-power rating associated with an unusually low load impedance and an evident vagueness about the level of distortion. Occasionally we encounter a low-powered unit with a spec offering no clue to type of rating, and such a product is probably best avoided, especially if further inquiry still leaves a kind of technical scotch mist around the more important parameters.

As already mentioned, it is usual to measure power at certain frequencies—for example, 40Hz and 20kHz as well as 1kHz, the latter being the standard frequency which the manufacturer has probably used. An exhaustive test report quotes power bandwidth as well. This tells you the range of frequencies over which the power is maintained and is therefore a useful supplementary item (the manufacturer may think the same way and publish a claimed



Squarewave oscillograms obtained with expensive hi-fi amplifier. A 1kHz, B 8 ohms, C 1kHz 8 ohms and 2 μ F, D 10kHz 8 ohms and 2 μ F. Mild overshoot is seen on the heavily reactive loads.

bandwidth). Usually the tester reports the power to the -3dB points, which is a range between points at the bass and treble ends where the power delivered falls to half that available at 1kHz . (It is useful at all times to remember that, in power terms, a 3dB increase is double and -3dB is half.) Very many amplifiers have a power bandwidth from about 20Hz to 25kHz , and a higher top limit is not really necessary. A lower roll-off, below 20kHz , is not at all encouraging, though.

Distortion, noise and sensitivity. One could quote magnificent power ratings for amplifiers if one conveniently forgot about distortion. However, the tester links the power firmly to total harmonic distortion. He uses a distortion meter and checks the summed harmonics relative to the output voltage. There are some problems with very good products, for we reach the stage where distortion in the measuring set-up competes with that generated in the amplifier! Amplifier noise is present in the readout but readings can be taken down to quite low power, as in the following example, taken from a published test report, of total distortion into $8\ \text{ohms}$:

Power <i>W_{rms}</i>	<i>40Hz*</i>	<i>1kHz</i>	<i>10kHz</i>
50	0.3%	0.1%	0.3%
10	0.1	0.06	0.32
1	0.1	0.06	0.32
0.1	THD below noise		
	* includes hum		



A



B



C



D

Performance under transient conditions of amplifier with class A output. Loads as before. There is negligible difference between performance on pure resistive loads and that on highly reactive loads.

With a sine-wave signal applied to the amplifier the tester checks the signal-to-noise ratio, which is the ratio between the rms voltage across the load at full power and the rms voltage across the load due to hum and noise in the amplifier. Noise (e.g. hiss) alone can be measured by inserting a filter in the circuit so that the hum component is attenuated. A total figure is usually given in reports, and if the voltage across the load is reported as (say) 60dB down, this means the hum and noise voltage components are 1,000 times below the signal voltage. With the volume control turned to minimum the ratio should be very high indeed; with the control at maximum the S/N ratio is given for the several inputs with their sockets shorted, and typical figures for a good amplifier are:

<i>Input</i>	<i>Hum and noise</i>	<i>Sensitivity at 1kHz</i>
Mag. PU	65dB	2mV
Tape	78dB	120mV
Radio	78dB	120mV
Aux.	76dB	90mV

Note that in the above example the input sensitivities also are quoted, and in a particular case the reader could compare the figures with those in the manufacturer's specification. The sensitivity figure is obtained with the volume control at maximum and tells us the size of signal required at the input to drive the amplifier to maximum power output.

For hi-fi it is of value to know how great the input signal has to be to overload the circuit's input stage and, since this is of special interest for disc replay, the magnetic pickup input overload margin is quoted in comprehensive reports. In the example in the above table the input overloaded at 110mV (at 1kHz) giving a 34dB overload margin, which is acceptable if not outstandingly good. A few otherwise good amplifiers tested in recent times have had worse margins than this—for instance, overload at 35mV for a 2mV input giving the poor margin of about 25dB. Although the routine test is at 1kHz, overload results worsen at much lower frequencies.

Interest in this aspect of overload has been running high with increased appreciation of the large velocities, such as 30dB relative to 1cm/sec in the mid-range, encountered on modern stereo discs. Although the output of the pickup may be only 1mV for each cm/sec, giving us a 'nominal' output of 5mV (as it would be quoted by convention), it is very much higher on peaky bits—transients that should be reproduced as cleanly as any other recorded material.

Apart from its effects on the reproduction of music, a poor overload margin can emphasise slight disc imperfections—very minor groove blemishes or static disturbances—to an unreasonable degree due to a form of transient distortion. A particularly unfavourable situation would arise with an amplifier of poor overload capability used with a pickup and speakers tending to exhibit coincident upper-range peakiness—a combination most likely to be encountered with the cheaper types of system.

Associated with the input performance is a check of the disc replay response equalisation. It will be clear from an earlier explanation that a special circuit is included in the preamplifier section (one for each channel) to tailor the response in accordance with the standard RIAA characteristic—essentially a built-in bass boost and treble attenuation, arranged in a precise way. The degree of precision is important and therefore the tester will check the deviation from the standard characteristic and, often, show the result in a graph, along with such results as tone control and filter characteristics. A

deviation of not more than 1dB through the major part of the audio range is expected of a good amplifier.

Damping factor. This refers to electrical damping—that is, control of oscillatory motion—of the speaker diaphragm by the amplifier (obviously a well designed speaker has acoustic damping of its own). The damping factor mentioned in some specifications is equal to the load impedance divided by the amplifier's source resistance, which is generally a small fraction of an ohm. Thus the factor is much higher than the speaker impedance, and a representative result from a recent test report is a factor of 50 at 1kHz and 40 at 40Hz, for an 8-ohm load.

Square-wave tests. Test results in the form of an oscillogram—a picture of the oscilloscope screen—can demonstrate welcome detail and save a lot of words. One feature is the inclusion of waveforms showing the signal with a conventional load applied and with a reactive load designed to show up any tendency of the amplifier to go unstable. Using oscillograms the tester can point out many details of performance—for instance, the way in which rounding of the leading corners of the square waves indicates high-frequency loss or the way in which very poor hf response tends to turn a square wave into a sine wave.

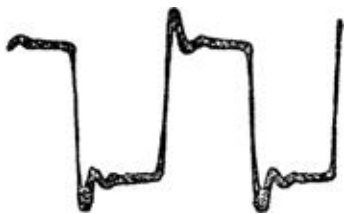
Basic tests. Group laboratory reports in *Hi-Fi Sound* have aimed to present, in uniform style to aid comparison, the results obtained with groups of products of similar type. With amplifier group tests certain minor or relatively uninteresting items have been omitted in favour of the tests which are of most concern to the enthusiast who wishes to compare a number of amplifiers



A



B



C



D

Typical squarewave results with capacitive reactive test load. A, Budget amplifier, showing mild overshoot. B, medium-cost amplifier with negligible overshoot. C, amplifier in the £100-plus range shows significant ringing. D, popular amplifier reveals some crossover distortion in the output.

before finalising his shopping list. These basic tests have been: power delivery; power bandwidth; total harmonic distortion; sensitivity of two inputs; magnetic pickup input overload; hum and noise; one oscillogram. Lab reports of a similar kind have also been devoted to pickups, turntables, tuner-amplifiers and loudspeakers.

Tuners

First and foremost is the sensitivity of the FM tuner, for this, taken with other aspects of performance, provides evidence that the equipment will prove acceptable to the enthusiast who wants to pull in a variety of transmissions. However, the sensitivity figure means little without qualification. As the aerial signal strength is reduced, the noise output of the tuner increases; therefore the sensitivity figure, in microvolts, must be related to a 'quieting' value or signal-to-noise ratio. This ratio is best when the aerial input is greatest—which will remind the reader of the experts' insistence on correctly designed, carefully sited aerials.

The greatest signal-to-noise ratio is a little over 60dB on stereo, but when the signal falls to about $10\mu\text{V}$, or a lower figure with the very finest tuners, the S/N starts to fall off. The greatest usable sensitivity is that given when the S/N ratio is around 45dB relative to 75kHz deviation, corresponding to 100% modulation. As will be observed from a study of test reports, some advanced and expensive hi-fi tuners have a genuine sensitivity up in the $2\mu\text{V}$ region. A figure of $10\mu\text{V}$ is otherwise common.

Tests are performed with a pre-emphasised ($50\mu\text{S}$ time constant) signal at 75 ohms into the aerial input, taking into account any matching requirements. Response is plotted from 20Hz to 15kHz, which is the upper limit on FM. This matter of pre-emphasis and de-emphasis (a counterpart of the disc recording characteristic and its replay curve already mentioned) is important for hi-fi: the British system employs $50\mu\text{S}$, some imported tuners and receivers $75\mu\text{S}$ unless this has been changed for the UK market (as it should be); and using the $75\mu\text{S}$ version on our transmissions will give an unwanted treble cut. Having the circuit of an imported tuner adjusted to conform to the British system will give the quality a lift, restoring the flat treble response that good FM should have. The user should not attempt this alteration of component values unless he is skilled in such things; but in any case the importer should not allow wrongly de-emphasised units to reach customers.

When the maximum S/N has been reached the tuner may be at the limiting threshold, so that any increase in signal fails to give an increase in audio output. It is usual to combine the sensitivity and amplitude limiting characteristics in the test report. A report goes on to mention the capture effect, which concerns the capture of the stronger of two signals when the tuner picks up both on the same frequency or adjacent frequencies. The capture ratio is given in dB and refers to the difference between two signals that will push the weaker one 30dB into the background. The lower the dB value, the better the ratio, and a very good figure is 1.5dB.

Other data include selectivity figures, stereo separation, muting, automatic frequency control, and the input signal required to operate automatic stereo switching (electronic switching) in the decoder. An interesting extra is suppression or filter operation, designed to delete components at 19kHz (pilot tone) and 38kHz (sub-carrier) on stereo to avoid beat-notes when recording on tape.

A large proportion of tuners have AM bands (especially medium waves) as well as FM. However, the sound quality via AM is far from hi-fi, and the performance of quite good tuners on AM is often indifferent (not to put too fine a point on it), and few test reports offer much information other than

confirmation that the AM section works as well as can be expected, perhaps with an associated sensitivity check.

Tuner-amplifiers

A tuner-amplifier (hi-fi receiver) combines in one housing the circuits and components appropriate to a tuner and a stereo amplifier. The radio coverage may be FM only or FM and AM. In a test report will be found the whole range of test results relating to these sections. No special features are to be expected. However, a unit that brings together audio and radio sections of the highest quality will be expensive—nearly the sum of individual unit prices. In contrast, some imported units have seemed uncommonly cheap, and so the tests may reflect the effect on performance of cheapening particular parts of the product.

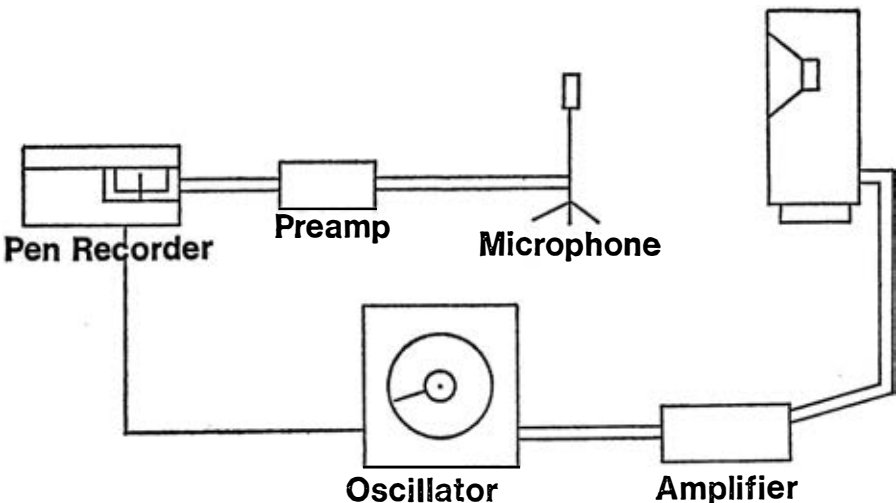
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CHECKING THE FACTS—II

SPEAKERS THAT can be associated with hi-fi systems start with miniatures at under £20, suitable for 'budget stereo' and spacesaving outfits, and range through a great variety of shapes and sizes up to the largest and most elaborate—at £150 or so—which meet the needs of the professional user and those fortunate enthusiasts who are able to plan systems totalling £500 or more. The number of models of all kinds runs into hundreds, yielding a wider variety than is found in any other type of audio product.

Although representatives of audio and radio publications hear a fair selection of these, sometimes only briefly, the number of models actually submitted for full tests and subsequent published reports is quite small. Even if a larger number were admitted into the queue there would not necessarily be any dramatic increase in the number of published reports, mainly because to run full technical tests on loudspeakers—at least as far as currently accepted practice is concerned—we require the use of an anechoic room (a sound-proofed chamber with negligible internal reflections). Such expensively equipped facilities are found in research institutes, universities and colleges, and industrial concerns including loudspeaker firms and manufacturers of test equipment—but not in publishers' offices! It is true that, to avoid reflections, we could do measurements in the open air (given quiet surroundings), but obviously a purpose-built anechoic room, with all the test equipment at hand, is the most convenient.

The first thing for the amateur to understand about loudspeaker test reports is that normally they offer no basis for comparisons. That is, a number of reports from different sources will depend on different methods of test, for there is controversy, rather than standardisation, in this field. (Lack of standardisation is evident in other fields, of course, but it involves less controversy.) Even if all the experts have used anechoic rooms (and that is



Equipment used for loudspeaker frequency response measurement.

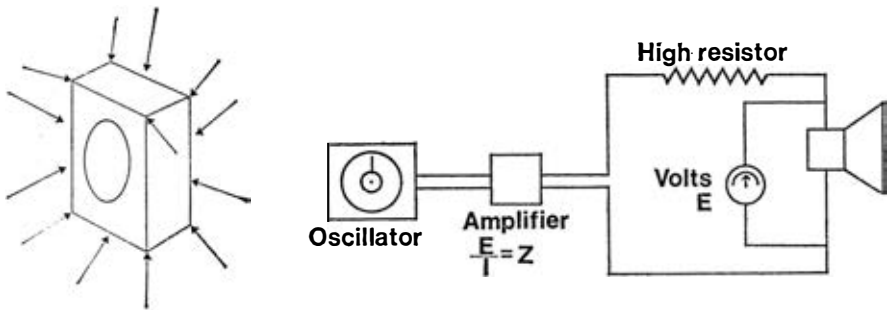
unlikely), these rooms will have different characteristics, affecting the results. On the other hand, the frequent use of an anechoic room by one authority, though leaving some scope for experimental error, may be expected to lead to some useful results that can more readily be interpreted for the benefit of the consumer.

A recent attempt by *Hi-Fi Sound* to study some aspects of performance led to the publication of a group lab report on eight speakers, all tested during one day in an anechoic room. Although this room, like others, is not anechoic at all frequencies, it did at least provide some basis for comparison. Even if frequency response traces tell you little about the sound of a speaker, they reveal general trends that are worth knowing; and it is very valuable to have distortion figures and impedance curves for a group of speakers subject to one set of conditions, just as it is useful to know their output (sound pressure) levels for a given input.

At present the aims are to learn more about speakers, to improve test methods and to interpret the test results to better effect. It is particularly desirable to find ways of relating the results to the behaviour of the speaker as a reproducer of music. An uncompromisingly technical report can make fascinating reading and may even tell the reader whether or not the speaker is *technically* suitable for his purposes (in respect of power handling, impedance characteristic, etc.) but it may conclude without giving an inkling of the quality or shortcomings of the acoustic output. For that matter, many test reports are really semi-technical descriptions and do not get very near to useful criticism of the product.

Of course, some people, with a little experience, may find that the more advanced technical reports suit them very well, in that they learn enough to exclude certain products from further consideration, and subsequently go on to listen to a small selection of more likely candidates. After all, if you exclude some models on grounds of unwelcome technical features, and others because of price or size, you narrow the field considerably and possibly save your ears a rather tiresome experience. It is certain, though, that it *is* necessary to hear some loudspeakers to appreciate the extraordinarily big differences between them. The customer who depends on manufacturers' reputations and a little reading—to the exclusion of serious listening—to choose speakers is risking disappointment.

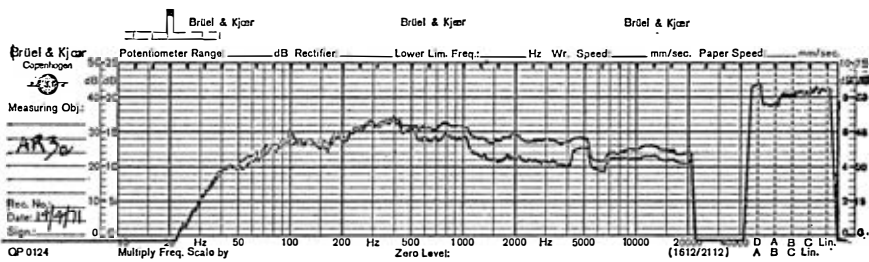
In this problematical and controversial area, then, it is rewarding to take note of attempts to bring some order to the proceedings. The uncomfortable meeting of personal taste and measured performance was highlighted in the



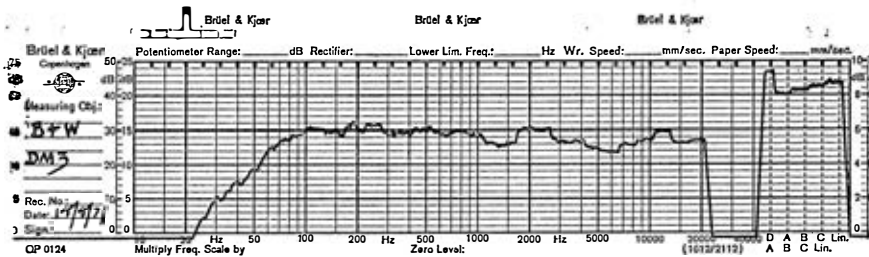
Left: Plots can be taken representing response as seen from virtually every angle.
Right: Measuring impedance characteristic.

laboratory report (July 1971) to which reference has been made: 'It is often said that the whole subject of loudspeakers—testing them, writing about them, choosing them—is intensely subjective. Arguments along these lines are sometimes presented to divert attention from lack of understanding of scientific method or lack of opportunity to practise such method. To say that loudspeakers are 'a matter of taste' and thus avoid the introduction of science is unhelpful and certainly unlikely to stimulate the design of better products.

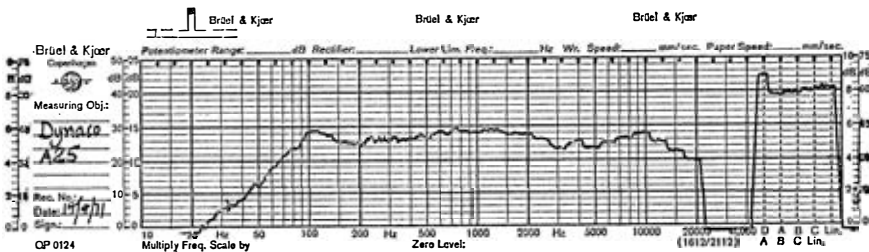
'In fact a high degree of objectivity can be brought to the subject; and through suitable interpretation of what is learned the buyer can be helped toward the necessarily subjective assessment that is a prelude to purchase. He must indeed make up his mind after listening to speakers, as if he were dealing with musical instruments, so the question of individual tastes and



Frequency response of AR3a speaker. Traces are with control at maximum (upper trace) and mid-position.



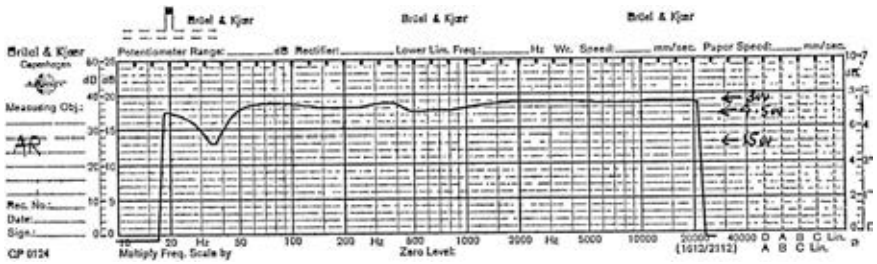
Frequency response of B&W DM3 speaker. Level control at mid-position.



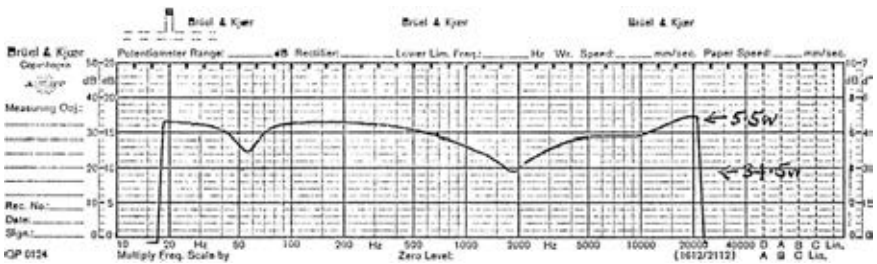
Frequency response of Dynaco A25/III. Control in the normal position.

preferences comes into this. What we should be clear about, however, is that the evaluation of the 'goodness' of speakers rests very firmly on facts, difficult though it may be to collect these and interpret them. Measurements of distortion, impedance curves, response traces—these and other matters show up the speaker's accuracy as a reproducer of the signals applied to it.'

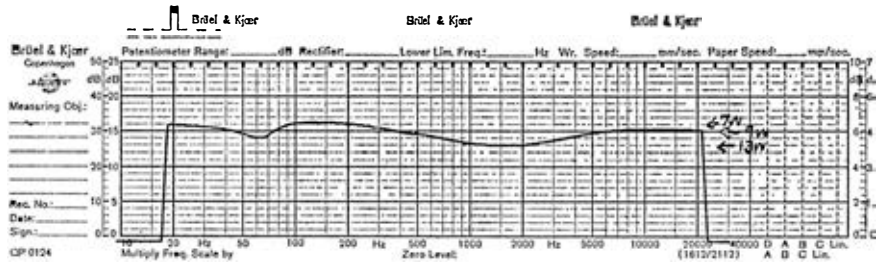
A few specialist manufacturers—mainly those with research and development facilities and the right sort of experts on the staff—as well as some of the audio critics and commentators, are trying to throw some light into the less accessible corners of the subject and are having to cope with loudspeaker folk-lore in the process. It is to be hoped that such investigations will help the industry's customers in two ways—through the development of more musical speaker systems and by helping the customer to choose more surely what is best fitted to his needs. Meanwhile, here are some features of test reports.



Impedance curve of AR3a. This shows 4-5 ohms average with a marked rise in the bass.



Impedance curve of DM3. Impedance rises in mid-range as well as if.



Impedance curve of A25/III. Fairly even characteristic.

Frequency response. Naturally we look first at what the makers claim. Usually we find that a frequency *range* is quoted, for example, 40–18,000Hz, without indication of departures—the ups and downs of life in the world of loudspeakers. On test we might find that the output was down by 6dB at the extreme top of the range—that is, a quarter of the acoustic power compared with the mid-range. The manufacturer could (sometimes does) quote a frequency response complete with dB limits. That would be a typical result under the manufacturer's conditions: there might be an anechoic room in the factory, or the firm's technical people might hire the necessary facilities for checking response and other aspects of performance.

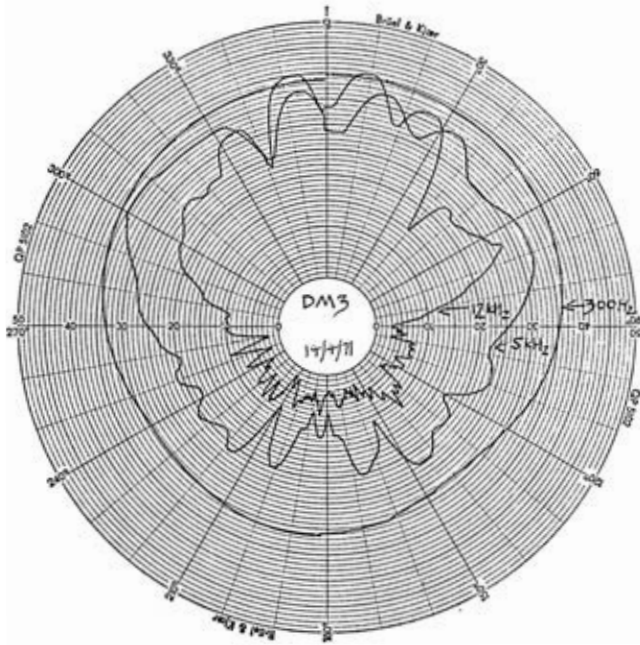
One trouble with response testing is that most popular systems employ two or more drive units and it is difficult to decide on a position for the test microphone, which is supposed to be listening to a single sound-source. When we have the response trace, which is usually produced on continuous stationery by B&K measuring equipment (see illustrations), we are not looking at an absolute result that shows how the speaker will sound in a domestic room, for the extreme low end and sometimes the top will be different, depending on anechoic conditions, although the general trends are helpful. Behaviour in the middle of the range is perhaps more revealing, and some speakers sound very much 'like' the peakiness that shows on the pen-trace in, say, the upper middle area (though that is not to say that a response curve reflects all causes of peaky sound).

In general the familiar on-axis type of response trace is a mixed blessing and the audio enthusiast cannot do much with it unless he considers it along with a good deal more data, so that an overall picture of the system's capabilities emerges. The dispersion of sound is not indicated at all by an on-axis trace; hence the increased use of traces depicting the response at specified off-axis angles. If the tester goes on turning the speaker round (on a special turntable in the anechoic room), a polar response graph results and a distribution pattern is built up, offering a little extra information bearing on the speaker's success (when in pairs) with establishing a stable and detailed stereo image.

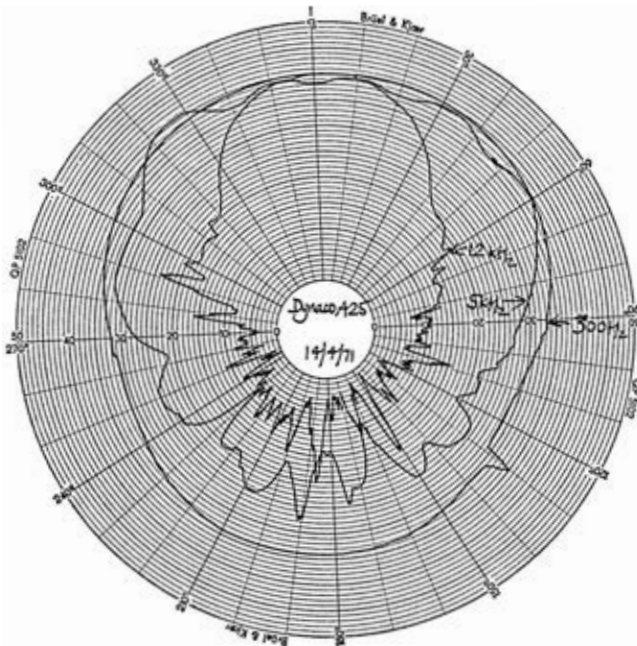
Experimental test routines have been worked out, the aim being to relate more surely the tests to the performance under listening conditions. For instance, Benjamin B. Bauer of CBS Laboratories has devised a method involving a series of measurements representing the response as seen from virtually every angle around the speaker. With the aid of a computer it is possible to determine the mean spherical and mean hemispherical response, showing up the system's smoothness and overall balance. As with the more conventional tests conducted recently by *Hi-Fi Sound*, Bauer's method involves the use of 'pink noise' (constant energy per octave bandwidth), which gives a much improved approximation to music conditions in terms of energy present through the audio range.

Efficiency. Many readers will know that loudspeakers are very inefficient, though they will probably have decided not to worry about it since the effects in economic terms of improving the situation are not at all clear. They may have seen figures of 1 to 5%, which are typical of compact speakers of the total-enclosure variety, the horn-loaded speaker being about twice as efficient.

Sound quality and personal preference for particular features of performance, rather than efficiency, influence the purchaser, but references to efficiency may be seen in some test reports. It is expressed as sound pressure level related to a particular input—i.e. a dB level for a specified input voltage applied by the test-gear. The efficiency reported by one tester should not



Polar response of B&W DM3.



Polar response of Dynaco A25/II.

be compared with that given by another under different conditions, but in a report on a group of speakers (or a series of reports stemming from one set of conditions) the figures give an indication of relative efficiency.

Distortion. The reader who discovers distortion figures in a test report is enjoying one of the more unusual results of scientific method (unusual because only rarely does distortion appear in specifications). Distortion shows up rather badly in anechoic-room tests and the results, though fairly revealing when it comes to comparing a group of speakers, are not very easily related to domestic circumstances. As experience is gained with collection and interpretation of results, testers should be able to comment in greater depth. Typical harmonic distortions are in the range 1 to 10% for popular speaker systems—daunting figures for those who admire amplifier test results and thrive on discussions of class A and class B amplification. Further work on distortion measurement (with tone-bursts, for instance) may in the future produce more meaningful accounts of a speaker's behaviour when fed with its proper diet—music. At present the more advanced presentations of distortion seem only to add to the confusion.

Impedance. Here the critic may well be on to something important. In a specification a loudspeaker has a nominal impedance, often 8 ohms but sometimes lower. The general idea is to look at the impedance at which the amplifier delivers full rated power, and then choose speakers to match. It is silly to arrange a gross mismatch and thus in effect throw away some of the watts for which one has paid. In practice very many amplifiers work most happily into 8 ohms, and the variety of speakers of that impedance is very considerable (a 'matching range' of 4–8 ohms amounts to much the same thing). Some imported equipments have a 4-ohm matching impedance.

So much for the figures on paper. The impedance of a speaker actually varies with frequency, quite dramatically in some cases. A variation of 6 to 20 ohms for an 8-ohm speaker is not unusual. A comprehensive test report will include an impedance characteristic (another pen-trace) showing this wide variation. The interesting thing about this curve is that it indicates whether the amplifier is likely to be able to deliver anything like its rated power at particular frequencies or parts of the range where the impedance is very high. On the other hand, if the impedance falls very low (below 4 ohms) it acts as a warning to be careful in choice of amplifier, for some models do not behave well when the load is dipping too low. A few high-grade loudspeakers have very even impedance curves, and the discerning user requiring a generously rated hi-fi system will wish there were more examples from which to choose.

Other test results. Readers may find other features including comments on crossover filters and their effects for good or ill (relevant to frequency response and power handling), resonance effects, and the influence of enclosure design on measured results. In the last-mentioned category may appear comments on designs intended for omni-directional dispersion of output, a topic discussed in *All about Stereo*.

Specifications sometimes mention such items as magnet flux and total field strength, quoting enormous figures in Maxwells, Oersteds, gauss and so forth. Reports on speakers have often made great play with these figures: so have advertisement copywriters aiming to appeal to quality-conscious buyers. However, the average purchaser of loudspeakers, although expecting information on (for example) impedance, response and resonances, is simply not competent to make anything of magnet system data. Generous, well designed magnet systems may well be a sign of good quality but there is no direct link between the magnetic data and the fidelity of the reproduction.

Tape machines

Although the beginner may not welcome the fact, tape machines suitable for association with hi-fi systems are rather expensive. Whatever form they take—the record/replay unit already mentioned or the complete, general-purpose recorder suited to occasional hi-fi music use—they are fairly complex. The mechanical parts are often elaborate and will therefore account for a substantial proportion of the cost if the quality is good; and the electronics (recording and replay circuits and control arrangements) must be precise in performance and the heads of appropriate quality.

This explains why low to medium-priced machines of popular type rarely feature in a test-report programme that caters for people interested in music recording to a standard that will compare with the best disc reproduction. One can obtain sound of a sort at low cost—but not high fidelity. Even a battery/mains portable of merit may cost £100 or so, and most good hi-fi mains tape units are above that figure, although a few units in the approximate range £70-100 have proved interesting enough to subject to full test routines.

Until very recently, cassette machines have not qualified for hi-fi test programmes—limitations, electrical and mechanical, have been too severe—but the situation is slowly changing with the emergence of high-grade cassette units employing improved mechanisms and the Dolby B noise-reduction system. These attractively small and neat machines cost as much as the bigger open-spool machines of comparable or better performance. Tests during 1971 have revealed the need for much attention to detail at every stage, from manufacture to use, if the best possible results are to be extracted from the low-speed compact cassette system. No doubt the better type of cassette machine will feature more often in consumer test reports in future.

In the UK there are no agreed standards for machines that are to have the hi-fi label applied to them. Very many of the spool-to-spool tape recorders reaching us from Europe and elsewhere are designed to meet the German standards specification, DIN. If hi-fi is the aim, the machine must have the $7\frac{1}{2}$ ips speed, as one would expect; so a test report will present the main results with reference to that speed but may also comment on performance at other speeds, $3\frac{3}{4}$ ips being the one most often included since for the ordinary user it can offer a reasonable balance between performance and economy in tape.

In view of the complexity of many recorders, and bearing in mind that the sample will most likely be new, the tester will run the machine for a time, checking for overheating, noises, proper functioning of the controls and other rather basic points. The checks can then be extended to normal use with a recorded tape, and a record/replay unit has to be associated with a high quality amplifier and speaker systems of the kind that would be used by an owner. Subsequent technical testing involves a signal generator, test tapes, oscilloscope, voltmeter, wow and flutter instrument, etc.

Frequency response curves claim a prominent place in a test report, and indeed response (together with noise level) will be the focus of attention as far as enthusiasts are concerned. It is worth stressing, then, that a well prepared report depicts record-to-replay response. That is, both the recording and the replay functions, including the tape, are taken into account and shown in the response graphs. Here it may be possible to see a marked contrast with a manufacturer's specification, for a different method may be used to obtain favourable figures for the sales literature. We must emphasise also that specifications of different makes of machine are not necessarily comparable.

The tester must also investigate whether the designer has been striving for an extension of high-frequency response at the expense of noise level, in order to obtain more attractive figures. It is still true that an expensive semi-professional machine may appear to have a less good response than a less costly popular portable, while tests will reveal that the former meets its realistic specification claims, dependably and within the confines of clearly stated dB limits.

Claimed noise figures may not be helpful since it is not always clear how much of the circuit is included in the claim. A test report normally gives overall results—recording to replay—and that is the S/N ratio that will interest the owner intending to make full use of the recorder. With record/replay units an important check concerns the level of output signal; this is often high and there may be no output controls, in which case an external hi-fi amplifier may exhibit input overload unless something is done to attenuate the signal voltage. Other check-points include crosstalk, track-to-transfer of signals, input sensitivities. Mechanical matters include checks of pulleys and belts; rewinding, braking, drive take-up on starting; tape tension; control operation including tape transport, pause control and tape position indicator; and suitability of different tape thicknesses for the capstan and pressure wheel.

5

SELECTING YOUR SYSTEM

FOR SOME readers the selection of a system is a pleasant job that is about to be undertaken. That is to say, they are about to decide how much to spend, as a prelude to a shopping spree—for a complete installation. For others it is more a matter of selecting one or two components. They may already own some equipment and wish to extend or improve it; or the whole system may have seen better days and therefore require general upgrading in such a way that the more audible advantages of modern equipment can be enjoyed. However sizeable the purchase, the comments in this chapter and the next will prove helpful, for the theme running through them is a popular one—how to spend wisely.

With that we are back to Chapter 2: first fix your budget, then keep to it. In fact, when selecting hi-fi you will be influenced by the money available, the facilities the system is to provide (disc only? FM now or later?) and some practical considerations such as the size of the room, furniture layout and general convenience.

Two important questions bearing on the selection of equipment deserve priority. One concerns the 'compatibility' of proposed purchases—a matter that many people feel must need close attention, even though they do not understand all the angles. The other has to do with power, which has already been explained to some extent but must be discussed again in terms of quantity!

Two plus two make . . .

System planning involves the most common-sense of requirements. Obviously you must ensure that one part of the system works properly with the rest, so that you achieve the best results. Two and two must—surely and predictably—make four. Equally obviously the requirements are of special interest to the enthusiast who buys individual components and then assembles the system. If he is wildly adrift in matching up quality standards he is likely to be disappointed with the performance.

Basic technical points are not unduly difficult. For instance, choosing popular components for record reproduction, the purchaser will find that most amplifiers make special provision for magnetic cartridges and that there is no need to finish up with a matching problem. Again, there are very many amplifiers that prefer 8-ohm speakers as their loads; and it will be apparent that the choice of speakers of that impedance is very wide.

There are some very powerful amplifiers and some very small speakers—the former intended for de luxe systems and the latter for flatlets. Put the two together and you have an expensive mistake. Of course, there *are* a few opportunities to go wrong, but a look at published information (specifications, test reports) should smooth the way to success with such basic matters.

However, there are some more interesting but less well understood aspects of component compatibility. Listening to representative examples of hi-fi stereo will promote understanding, while hasty purchases may well lead to disappointment and damped enthusiasm. A good example to take is pick-up/loudspeaker compatibility. As we have seen, peakiness of response and distortion are most likely to afflict pickups and speakers (we can ignore the amplifier for the moment) and a quality of brash hardness or 'presence' may be noticed in some cases—probably, but not necessarily, the cheaper products.

One mildly 'peaky' performer (a budget-price cartridge, say) may be found acceptable, but strong peakiness in both pickup and speakers, with the response peaks coinciding, is likely to produce an unnatural effect on music, and perhaps an emphasis of noise that would not otherwise be worthy of comment.

It may be held that criticism of a certain amount of brightness brings us up against individual taste; but it is possible to avoid such effects—the most expert designers manage to do so—and experience of listening should lead to the conclusion that emphases producing a synthetic or glassy quality, especially in the mid-range where the ear detects it so readily, are tiring and in conflict with hi-fi. Moreover, complaints of unnatural voice reproduction, 'hard' stringed-instrument sound and generally rough quality are in fact levelled against hi-fi and can often be attributed to peaky colouration and associated faults (pickup mistracking is another cause of rough sound, not necessarily linked with peakiness).

Unnatural emphases could also occur in the bass. There are several reasons for bass-heavy or lumpy sound: the speakers alone may be responsible for dissatisfaction in this respect, or there may be some deficiency in the design of the amplifier that also contributes, and it is possible for the pickup to come into the equation. A question of 'compatibility' may arise here.

More to the point at the moment, however, is the sadly ignored factor of what may be called speaker/turntable compatibility! It has already been made clear that a high quality system demands a high quality turntable—a good example of the transcription type is advisable. The symptom of incompatibility is our old friend—rumble. A continuous low-frequency interference worsens the signal-to-noise ratio and stifles dynamic range. In a system of really fine quality, even a slightly noticeable background noise is objectionable and contributes to listening fatigue. It may not be so evident that a related effect is a masking of fine detail in very quiet passages of music; remove the interference and the veil is lifted. Enthusiasts making a change for the better have been surprised to hear recorded details that formerly went unrecognised!

In general we require better turntables (less rumble) when we decide we can afford good loudspeakers (quite often the biggest speakers, as it turns out) with an extended bass response. However, two big speakers may expose rumble in different ways, according to their behaviour at very low frequencies, and the annoyance level of rumble does depend on speaker performance. It is a subtlety that can be appreciated after listening to some equipment.

A related point—a practical one for many people—concerns the choice of pickup (arm and cartridge), which can be selected with a view to its own special merits if it is a separate component. But if a combined turntable/pickup is required, as is often the case, not only must the turntable be suitable but the arm fitted to it must be good enough to track a cartridge of the quality appropriate to the system.

There are other compatibility points, and some can be discussed only with reference to specific products. The intending purchaser will find guidance in test reports and advisory articles. For instance, certain amplifiers perform happily with the curious (electrically speaking) loads imposed on them by electrostatic speakers; others are unsuitable for this type of speaker and simply will not drive it satisfactorily.

The power game—again

We have looked at the power game that manufacturers play. Continuous ratings, music power and so on have been explained, and we have settled for continuous ratings based on sine waves—the honest watts featured in

test reports. Now we can go on to consider the question: 'How powerful?'

Popular amplifiers for hi-fi stereo start at around 10 watts (10W) per channel; there are many at about 20-25W; and if you want more you can buy at least 50W per channel. There must be good reasons for producing amplifiers and tuner-amplifiers with such a wide spread of output powers. Which will you choose, and why?

You may feel that, since you are not planning to stun your neighbours with very loud sounds, a modest ration of watts will be acceptable. You will realise, too, that cutting the rating has a pleasing effect on cost. That beautiful 25W unit sells at £65 but the 15W model is yours for £40. But neither your relationship with your neighbours nor your ideas about economies have much to do with hi-fi. If you want the finest results, you should be looking at power with quite different requirements in mind, and for a start you will have to accept that the loudness you experience is not directly proportional to the power of the system. If that were the case, a 50W amplifier would sound five times as loud as a 10W amplifier—and *that* would completely revolutionise hi-fi and much of the communications business as well!

If you want to hear a definite increase in output you have to raise the sound level by 3dB. That is a very modest change and would involve a small adjustment of a volume control. But an increase of 3dB means doubling the power. So if we take it that a 10W amplifier is found inadequate, the first worthwhile change is an increase in rating to 20W (assuming that the bigger amplifier is the same as the smaller one in every way except output power).

Next, would you like to play safe and leave a small margin? It is certainly in the interest of hi-fi. That calls for another 3dB, so the rating goes up to 40W. (You will begin to see why pop festival organisers hanker after a couple of kilowatts; they like big margins, not small ones.) In fact you should consider all this before any inadequacies are revealed; you should choose a power rating that suits the conditions of use. And these 'conditions' embrace room size and the amount of background noise where you live.

Even that is not all, for the efficiency of the loudspeakers comes into it. Two speakers on your short-list may well have different efficiencies, so that one will emit more sound than the other for a given input. You can try it when shopping for speakers provided the showroom is equipped for direct comparisons. (We are concerned here with quantity, of course, and efficiency is not a guide to quality.) However, there is not an enormous difference between popular speakers in this respect, unless one takes a rather extreme case and compares a horn with a small total-enclosure model; and in any case the wise buyer will choose his speakers with an ear on the music and an eye on the price-tag, and the best he can do about this matter of efficiency is to make sure there is enough power in the system for the prevailing conditions—the point that has already been made.

Reserve

Now for some hi-fi recommendations. Freedom from listening fatigue—an impression of ease in the reproduction—is fundamental: that much was made clear earlier in this series. Assuming the equipment is of good quality a contributory factor is an adequate power reserve. This is not a recommendation to go to extremes, and there is no point in using, say, a 50W amplifier with speakers that can only handle 10W transient peaks before sounding distressed. What we require is a comfortably rated system—one that is 'cruising' and not constantly running flat-out. The behaviour of the amplifier comes into this, and one may 'sound' good right up to its maximum while another may seem decidedly rough due to a steep rise of distortion.

Note the use of the expression 'transient peaks'. Average powers are

quite low but fleeting impulses of power must be handled as smoothly as everything else—and they can be surprisingly big if the system is used at levels that provide realistic results. These levels are set by the listener, who turns his volume control to the point where he can judge that the expected dynamic range is acceptable. If the ambient noise is high, perhaps due to traffic on a nearby road, the level will be set to convey the high fidelity illusion in spite of the interference. Below this level, the details of the music will not be clear.

Of course, the level may be set somewhat lower if the listener lives out of town and away from traffic. It would be lower still if he listened only at night. For very many people there is an ambient noise level in the room, in daytime, of 40dB or so. It seems a large figure, but in everyday life we are accustomed to listening for information we require while we push away the noise. If the dynamic range is to be 60dB the programme sector is 40-100dB approximately. Even a small increase in background noise, however, will force the dynamic range bracket upwards—perhaps to the point where the corresponding power handling capability becomes unthinkably large.

In fact it may not be practicable to fight the programme-to-noise battle to its end, however keen we are on hi-fi, but at least it is possible to seek a sensible compromise and try for a reserve capability that will meet hi-fi needs most of the time. The rating depends on room size, and it is surely not difficult to accept that a very large room will require relatively generous amplifier power and, of course, loudspeakers that handle the big transients gracefully (they will probably be fairly sizeable speakers in this case).

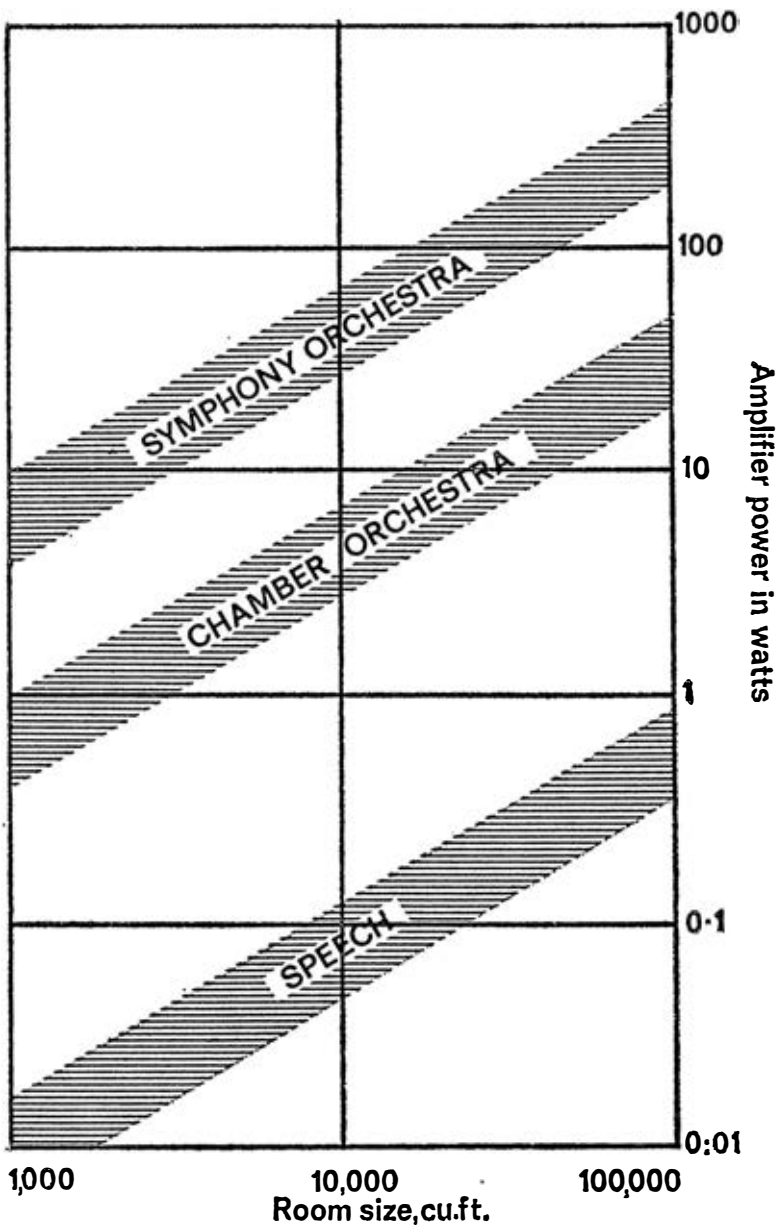
For a small room in a flat the power will be lower, and in any case problems of size and space will lead to choice of a very compact system that is likely to be of restricted power handling capability. Many 'budget stereo' outfits are suited to small rooms but would sound undernourished—even objectionable—in much larger rooms.

Minimum needs

It will be evident that a number of factors come into the 'power game'. With a thought for compromise, power requirements are charted in the accompanying illustration, which has been used before by *Hi-Fi Sound* to provide a rough guide. It is based on average conditions—typical speakers and background noise levels—and can only convey some impression of what it is reasonable to aim for. It reflects minimum requirements, and there is everything to be said for safety margins.

This is the moment to emphasise that volume control settings are *not* readily related to what has been said about power and listening levels. The power delivered by the amplifier depends on what is going in at the other end—a point to which few enthusiasts give much thought. The amplifier has a certain input sensitivity, and this means that a particular input (signal) voltage will cause the output stages to be driven to full power.

Thus, use a particular pickup generating a particular signal voltage, and the volume control will be at some setting (let us say half-way) when the required listening level is established. Use a different pickup giving a higher voltage and, overload considerations apart, the volume control setting will be lower. The moral is: when in doubt about power ratings look first to the input, and remember that the volume control is an indicator of the signal passing through.



Suggested minimum power requirements to give adequate levels under normal listening conditions. This provides a rough guide to power per channel for stereo, but adverse circumstances—higher sound levels, less efficient speakers—lead to greater power requirement. See text.

A few more golden rules will aid the summing-up:

- ① Loudness is not directly proportional to the power of the system.
- ② Without enough power for the conditions of use, you cannot have a realistic dynamic range.
- ③ A generous power reserve (within reason) is a good thing. A shortage of watts is not. Relate power needs to room size.
- ④ The setting of the volume control is not a guide to the power.
- ⑤ Economy-class systems with low power ratings and inefficient speakers are suited to small rooms only.
- ⑥ A powerful and *smooth* system does not sound very loud in normal use.

Keeping the balance

Enthusiasts seeking advice on new purchases often make the twin points that they regard a high fidelity system as a major expense and that they cannot afford to make mistakes, only to be faced later with alterations to put things right. One possible mistake is an underpowered system, as we have seen. Another would be the choice of equipment that disappoints on grounds of sheer tonal quality. Adequate planning and careful listening to speakers and pickups should pave the way. But the most serious mistakes generally involve the choice of incompatible components, so that the performance exposes the weak link in the chain. Maintenance of a reasonably uniform quality level is the best approach.

There may be exceptions, made with knowledge of what is involved. In many systems there is much to be said for using a pickup of better quality than the general standard would seem to warrant. This is because the superior tracking capability of a high-grade pickup is always worth having, and the advantages are apparent through all but the most indifferent speakers. And the better the pickup, the more gently the records are treated. This is obviously a practical matter, for discs kept in virtually mint condition will give the most pleasure if more is spent on the hi-fi in the future. On the other hand, although good loudspeakers are always easier on the ear, a disproportionate outlay would probably achieve little if the amplifier could not drive them adequately. A brief introductory guide to budgeting appears in Chapter 2.

Exceptions are often proposed by those with budget problems. A typical question is: 'Should I make sure of the amplifier now and carry on with my rather cheap existing speakers until I can afford better?' The answer is that the relatively expensive amplifier will yield little in terms of listening pleasure until those better speakers are in use. Another proposal—surprisingly common—underestimates the importance of the pickup cartridge, which turns out to be ill-suited to the standard of equipment purchased. The standard of record reproduction is set by the cartridge and you cannot compensate for its most serious deficiencies.

Another question is: 'Shall I spend more freely on the speakers and use an XYZ amplifier as a temporary measure, buying a more powerful model later?' This is a possibility if the contrast is not too extreme, and much depends on the output power and quality of the XYZ. But temporary measures are often unsatisfactory, and piecemeal assembly of hi-fi is hardly to be encouraged.

Everything under control

Some amplifiers and receivers have a few knobs and switches for the most obvious functions—volume, bass, treble, input selection—and others have rows of keys, toggle switches and meters. The more fanciful arrays are found on the most expensive units, needless to say. Every little gadget adds something to the manufacturing cost, and the total cost of the extras may well add pounds to the price.

The question is: are they extras, or do you consider them essential? One might suppose there could be general agreement on what is needed for proper control of a stereo system; and so there is, so far as the basics are concerned. But still there is debate about the merits of the possible additions. Some have always maintained that there is *too much* under control and have sought to simplify, pointing out that money saved on a selection of minor features could be put to good use in optimising performance. There have been isolated attempts to rationalise even basic controls out of existence—for instance, a return to a 'tone' control instead of bass and treble controls.

Contrast this with the de luxe units from abroad with their much wider variety of facilities, some of which can be used only occasionally. Some large producers, especially in Japan, send equipment to several countries and put in a generous quota of features, likely to appeal in their main markets, which include the USA. New four-channel units seem to be sprouting elaborate controls, and further experience will show what the basic functions should be like.

All of this is of interest to the enthusiast who is about to choose new equipment and a short account of controls and their purpose may be of help. The use of volume, bass, treble and input selection can be taken for granted at this stage, though it is as well to stress once more that the volume control is best regarded as a tap, turning on the signal and letting more through to drive the output stages towards their maximum. As for the rest, they will be labelled in some way—sometimes confusingly, with clever symbols, due to the problem of including information in a very small space.

Filters—treble and bass—are fairly popular and some sort of filter control may appear on even a medium-priced amplifier. Unfortunately, if it has claimed very little of the manufacturing cost or design effort, the filter is unlikely to be of much practical merit. Filters on the cheaper amplifiers and tuner-amplifiers seldom provide a good filter action, and in that case one may as well use the tone controls to achieve the same effect. The same, alas, is true of some of the more expensive models.

A low-pass filter, as its name implies, passes signals below a certain frequency. In other words it is a 'high' or treble filter, possibly operating up in the 8-10kHz region. The rate of attenuation of the filter action—its steepness—is important, and a well designed filter gives a fairly steep cut. Rough-sounding signals, exhibiting certain kinds of distortion, or signals with an accompanying high whistle, can be cleaned up to some extent by filtering them in this way. A few manufacturers refer to 'scratch' filters—a term left over from the days of 78rpm records. Some of the best filter designs offer control over the rate of attenuation.

Obviously such a filter has its uses—when programmes of doubtful quality are reproduced. However, some of the more devoted hi-fi enthusiasts seem to attach more importance to the low-pass filter than to anything else. It is surely a curious practice to spend a great deal on securing an enormous bandwidth, only to cut it down to mid-fi most of the time. The aim should be to seek good programme material; if you have plenty of that to listen to, you will find the filter is practically redundant. But you cannot win all the time; hence the filter, which will (or should) ruthlessly chop your frequency response while removing the 'whiskers' from the more hairy kinds of signal.

A high-pass filter lets signals through above a certain frequency and attenuates everything below that frequency. This facility appears on the amplifier as a rumble filter, operating at around 30Hz. If this filter is in constant use it may mean that the turntable is not good enough for the system! However, some amplifiers have a built-in cut at a low frequency, and some experts believe it is good practice to remove the very lowest (up to about

30Hz) information—or rather, the random impulses of large amplitude that may arise. They would perhaps except the finest professional, monitor-class systems in which the loudspeakers may be capable of reasonably accurate reproduction down to about 20Hz.

A gadget called a 'loudness control', found on a few British units and on very many imported models, has been the subject of controversy for a long time. Those who first introduced it believed they did so on a scientific basis, and they have been followed by many manufacturers who assumed they could not sell their product without this facility. To cut a very long story short, the tonal balance in reproduction is upset when we listen at low sound levels, and the loudness control circuit is designed to apply some bass lift (and sometimes a smaller amount of treble lift) in order to restore the balance. There is no standard practice, and the boost of the control is sometimes absurdly great; but for those who wish to check what happens, the response with the control in use will usually be found in the test report on the amplifier.

With high fidelity systems the result of switching in the 'loudness' control is nearly always very unrealistic; but in any case hi-fi running at realistic sound levels is in no need of special response contouring. (Cheap, no-fi players may benefit to some extent from synthetic bass, promoted by a boost.) It seems, then, that systems so often provided with the loudness control have the least need of it. If a change of response *is* favoured for low-level listening, a touch on the tone controls will provide all that is necessary. Hi-fi equipment with a non-switchable loudness control cannot possibly be regarded as acceptable.

Adjustment of stereo balance is essential; hence the balance control, affecting relative gain in the channels. It is not used a great deal but will be needed if there is obvious unbalance in the stereo signals. Slight unbalance could arise at the pickup end of the chain, or there might be some feature of the recording, susceptible to partial correction (though a really faulty recording cannot be entirely corrected).

The stereo 'sound stage' established across the region between the speakers is shifted by the control, as a little experiment will prove. An amplifier with dual volume controls, concentric or separate and one for each channel, does not have a balance control. But a separate balance control is usually favoured and is the easiest to use. It may produce only a few dB difference in the channels, or it may fade one channel out at maximum travel.

Much less widely featured are channel switching controls. One kind of control, moderately useful, reverses the left and right channels. Another, rarely included, changes over the 'phasing'; but in any case a speaker phasing error is simply corrected by reversing the wires on one speaker, and we hardly need a control to help! Familiar switch controls are stereo/mono selectors and controls associated with tape recording. Then there are meters, such as those 'level' meters that indicate the signal going through to drive the output stages (they do not tell you about your output power).

Some amplifiers are designed to drive more than one pair of loudspeakers and therefore have the appropriate switching for combinations of speakers. Remember, though, that in the absence of such controls, it cannot be taken for granted that the amplifier will be happy with extra speakers in parallel with existing speakers. The result of paralleling speakers is to lower the load impedance, and this must not be done unless the instruction handbook is specific on the point. If in doubt, ask the amplifier manufacturer. An incidental comment: speakers in series raise the total impedance (add the individual figures) but this arrangement of speaker loads is hostile to hi-fi though it does not damage amplifiers.

Budget stereo

Although everyone making a major purchase has a budget in mind, the expression 'budget stereo' has fairly wide currency and is associated with economy-class systems. It seems to have become a subject in its own right, and certainly the sales of small stereo outfits are very considerable. Many people, including some who would otherwise buy stereograms, are sufficiently interested in above-average sound quality to spend up to about £100 on audio, although they would probably not feel the sort of enthusiasm that leads to a system costing over twice that figure. That is not to say that 'budget stereo' is exclusively beginner's territory; the musically inclined would derive great pleasure from a first hi-fi purchase at a much higher level of quality.

It is largely a matter of genuine appreciation of music, available cash, size and convenience. As for the last factors, many of today's matched outfits and individual units appeal because they are small as well as fairly cheap. They suit the user who finds it difficult to accommodate new objects in a small room that is already normally furnished (wall-mounted speakers may be the solution). They may also attract the man who has plenty of space but no inclination to devote much of it to hi-fi. A low-powered outfit is suited to a small room, but installing it in the spacious lounge is decidedly risky, especially if the room is well furnished and contains a lot of sound-absorbing materials. An underpowered system can sound very strained and unrealistic in a large room, and there is the danger that matters will be made worse by the poor signal-to-noise performance of an inexpensive set-up working under adverse conditions.

Assuming more favourable conditions, what are the features of an economy-class outfit? For a start, extreme economy is *not* a feature. Only a few people can produce something small but good for £50-60, and usually they put a lot of effort into it. The most obvious way to make savings is to construct some of the equipment, with speakers as the first choice. For people who are neither technically minded nor handy with tools and materials the advice is—wait until the mini-budget has grown.

Simple audio units, well suited to shelf mounting, will appeal to most people, and the variety is reasonably wide. Controls and facilities are reduced to basics, and one of the main aims is to obtain the most generous power rating for the money (about 10W per channel can be expected). Small hi-fi speakers, as already indicated, are generally among the least efficient, and so we have an awkward situation. Adequate power is needed to drive the speakers, but the ration of watts is small because of the budget. The best that can be hoped for is a reasonable compromise.

The outfit will be completed by one of the few inexpensive players and a magnetic cartridge that can be tracked securely by the pickup arm. FM radio can be added at some other time. Be warned that *very* cheap amplifiers and systems are characterised by restricted power delivery. A tempting mid-range power may be quoted, but tests usually show that performance falls off seriously towards the extremes of the range, and the signal-to-noise ratio is often poor. It is simply not realistic to expect the stronger features of genuine and complex hi-fi systems at very low prices.

A few other guidelines. Where the power rating is necessarily rather low, pay special attention to impedance matching as this will ensure that the best possible transfer of power is achieved. It is silly to waste any of the small ration of watts. This is merely a matter of attending to the nominal matching value—usually 8 ohms with transistor amplifiers, unless there is some instruction to the contrary (as there may be with some imported units). There are plenty of speakers of this nominal impedance—and lower—to suit

budget stereo. Power ratings of loudspeakers are of no consequence at all in this context, since any popular bookshelf speaker is happy with any small amplifier as far as input wattage is concerned.

It is hardly surprising that enthusiastic amateurs, anxious to make a start, think up schemes that seem to offer short-cuts to stereo. They think of obtaining further service from amplifiers salvaged from stereograms; they propose using cheap record changers or unidentifiable speaker units that may have thumped away loudly in a stereogram but will be of no use in hi-fi arrangements. Experiments with old components may be interesting but cannot be expected to contribute anything of merit—even at the modest budget stereo level.

Using headphones

To some people the idea of clamping headphones on one's head to listen to music is amusing, even absurd. They associate headphones with the radio 'ham' and experimenter, listening to messages at communications quality, or perhaps with professional users who have to concentrate on the information and exclude unwanted noises. But modern headphone reproduction is of excellent quality, and the twin-channel directional information of this form of stereo (or, if you prefer, binaural) reproduction is very marked.

In fact the use of headphones has been rapidly increasing and very many listeners find it convenient and peculiarly satisfying to retreat into their private world of sound—late in the evening, for example, when they would disturb others with the hi-fi and in any case would find low-level loudspeaker reproduction very tame (loudness controls notwithstanding). Headphone reproduction can be at any level you can bear, and no-one will be any the wiser! If you listen to 'phones very often (and some people are practically addicts) you miss a great deal that loudspeaker stereo can provide, but that is not to deny that the headset can be a great convenience or that the reproduction can have considerable realism, refinement, wide response and other desirable features.

The quality via the more expensive models, costing about as much as a small speaker, will surprise many listeners who have not yet taken headphones seriously. A wide range of cheaper headsets, centred on a figure of about £8, can also give great pleasure in occasional use, although they do not exhibit the very low distortion, excellence of transient response and general airiness and delicacy of sound that the most advanced models can provide.

The great majority of 'phones incorporate moving-coil units—like tiny loudspeakers—but a few electrostatic transducers have reached the market. Using good headphones one becomes very aware that one is in close touch with the characteristics and quirks of the recording or broadcast and that room effects have been excluded.

Most models, at most prices, are nicely made, not excessively heavy, and fitted with soft earpads shaped so that there is good coupling to the ears. However, the range of mechanical adjustment of the earpieces is sometimes very limited. Much is made of the fact that the sound-stage swings around with movements of the head; but that is exactly what one expects will happen, and it is hardly likely to bother the person who settles down quietly to listen. Headphone reproduction is just 'different' from speaker sound, and the sensible listener would hardly expect it to be otherwise. More serious is the tendency of the forgetful user to stand up suddenly—an impulse he has to learn to curb, especially if the connecting lead is short!

The majority of modern transistor amplifiers have outlet sockets for headphones. Most often these are for low-impedance 'phones (roughly 8-50 ohms) and if some different arrangement is intended there will be mention of it in the

specification. In the conventional arrangement the socket is linked to the amplifier's output stages via limiting resistors, the aim being to obtain a good signal-to-noise ratio, with a convenient rotation of the volume control, with the headphones in use. Without such an arrangement the sound level through the 'phones would suddenly reach the unbearable level with just a touch on the volume control.

Headphones produce high levels with inputs of less than a watt, and therefore the questions of power rating discussed earlier are not relevant. Impedance matching is not very critical, and any headset of nominal 'low' impedance can be plugged into an amplifier having the appropriate facilities. It is often the case that plugging-in mutes the speakers.

To choose a headset, make up your mind about the price limit, listen to a few examples, and check the amplifier specification or instruction manual. Consider the range of headset adjustment as well as matters of general convenience, according to the amount of headphone listening you expect to enjoy. Pay attention to headset weight and ear comfort if you propose to spend hours each week in your private binaural paradise.

If the amplifier has no socket, this does not make headphone listening unduly difficult. The connection can still be made via the limiting resistor—a point that will be covered in the next booklet in this series. Alternatively, use one of those very convenient connecting or junction boxes. There are units that provide headphone/speaker switching, volume control on each channel and outlets for two or more headsets. The problems that many people fear they will encounter simply do not exist.

A final note is closely related to advice already proffered on the subject of 'budget stereo'. Obviously a system for headphones can be cheaper than any other, but the decision has to be made at the start to exclude speakers. There are one or two small headphone amplifiers which produce just enough power to drive a couple of headsets. A typical outfit would include a low-cost turntable unit (a magnetic cartridge could be used) and, perhaps, a radio tuner. A tape recorder could be connected if required.

Playing 78rpm discs

Many record-collectors, especially those who have taken an interest in audio over a number of years, still possess 78rpm records and derive pleasure from an occasional listening session. A well cared-for 78 can sound very acceptable and the silky surface noise of an unworn disc, played with a modern magnetic cartridge fitted with a stylus of the correct size, is not unduly obtrusive. Better to reproduce this noise and hear the recording properly than to filter away at least half the response. Enthusiasts sometimes propose using ceramic cartridges for 78s but the attraction of cheapness is offset by the risk of emphasised surface noise, which may sound gritty.

However, it is becoming more difficult to make provision for playing 78s. This is because few of the best turntables, so attractive for high-grade stereo, have the 78rpm speed. There is little demand for this speed, of course, and we cannot expect manufacturers to allocate cost to an obsolete feature.

For those who find a turntable that offers this speed plus the other features required for a modern system, the way ahead is a little easier. As far as the disc equipment is concerned, the best choice is an arm with a plug-in headshell. A second headshell can be purchased, and in this one can fit a cartridge with 78 stylus. Leading makers supply 78 versions of certain models of cartridge and stylus (Goldring and Shure, for example). If a high-class stereo magnetic is to be used, the other cartridge can be similar in principle—that is, magnetic and stereo—but perhaps a cheaper version if there is one.

Since the 78 set-up (used as mono) will inevitably require a greater tracking weight than is customary for stereo LPs, the headshell can be loaded with a small piece of metal representing the difference between the two. Thus the pickup arm setting can remain undisturbed. Bias correction can be ignored for 78rpm and the arm left at its stereo setting at all times.

That is one method enabling 78s to be taken into account at the planning stage. A couple of electrical snags of a minor kind remain. The 78 pickup will probably generate a higher signal voltage than the stereo LP counterpart, but correction of the difference, other than with the volume control, is hardly worth while. Modern amplifiers do not include any response equalisation for 78s, and therefore the reproduction will have inaccuracies right through the range. Some experiment with the bass and treble controls will modify the effects of the built-in LP equalisation and yield a compromise that should be acceptable.

Buying secondhand

Few people will need reminding that used equipment should be carefully investigated before money changes hands. Perhaps the best secondhand buy is an item with a known history—possibly the property of a friend. You may know that it has had the kind of careful use you yourself would give it.

However, when confronted by a strange piece of apparatus with an attractive 'asking price' you may feel encouraged to try it out and inspect it closely. Given the facilities for a proper trial you should be able to learn a lot from listening, and an inspection may reveal signs of either recent attention, such as a works overhaul, or interference with vital parts.

Used loudspeakers are often good propositions. They are not usually very complicated and gross carelessness or a system fault would be needed to damage them. Of course, a speaker *can* go faulty but a careful check with music at a realistic level should tell you what you want to know. After that it is mainly a matter of inspection for cabinet blemishes.

Mechanical items such as pickup arms will probably reveal any serious faults—check for pivot stiffness, distorted fittings, damaged terminals—but electronic equipments of all types present many hazards, roughly in proportion to the number of components incorporated. Listen for distortion, try the controls and, especially, check that the signal-to-noise performance seems normal. Modern units, particularly British products and the imported ones coming in via large and established distributors, can be serviced if necessary. Rare models should be avoided.

Pickup cartridges are reasonable propositions. A faulty cartridge body (containing fixed parts, coils, magnet and what-not) is not often encountered. The most likely fault is a distorted or otherwise damaged stylus assembly; or you may not be sure of the condition of the stylus tip. Either way you have to consider stylus replacement and will have to bear in mind that, if the cartridge was an expensive model, the stylus assembly also will be fairly expensive. Replacing the stylus does, however, restore the used cartridge to new condition. A few models, notably Ortofon moving-coil and Decca, go back to the works for servicing. Do not buy exotic cartridges unless you know that replacement styli are available.

Turntables are tricky items. A recent model, running sweetly and quietly, may seem a reasonable purchase. But if the unit is a potential 'rumbler' the fault will have to be very bad before you can recognise its nature on the basis of a short inspection and trial. It is more likely that you will have it carefully installed along with the pickup before the rumble becomes apparent.

6

WHERE TO LISTEN

FIRST THINK of budgets and short-lists but do not delay too long before making sure that the equipment meets requirements as a convincing and natural reproducer of music and speech. Recommendations, technical advice, comparisons of data: useful as these things are, there is no substitute for an audition. At the final stage your own tastes and preferences come into play and, while consideration of technical matters can guide you towards suitable types of equipment, your choice will still be influenced by your idea of how music should sound.

It should be obvious that a system purchased without an audition might meet all known technical requirements, for your careful researches could ensure that nothing was forgotten. Indeed, a system assembled on the advice of experts who hear a great deal of audio might turn out to be first-rate if you accepted it without hearing it first. On the other hand, it might not. Most people with systems—or even individual items (e.g. speakers)—in mind can learn a lot from well conducted demonstrations.

Despite the evident need to hear hi-fi, to allow for subjective comparisons and to check facts about audio against the reproduction, many would-be owners seem intent on finding short-cuts. That much is clear from the questions they ask—typically ‘I want the best possible sound from organ (or vocal, or orchestral) records, so which type of equipment should I look for?’ The best hi-fi is the sort that presents everything faithfully, and it really is necessary to hear what is involved.

The man who can have the whole system brought to his home for a trial is fortunate, though there is no doubt that the domestic room is *the* place in which to audition a sound system—or loudspeakers—intended for use there. For many people, buying hi-fi involves a visit or two to showrooms and shops, and the choice, not uninfluenced by previously gathered advice and technical information, will be made there.

This brief account cannot cover all the possible contrasts to be found in retail establishments, but it is safe to say that a sampling of them will make you familiar with the ways of salesmen—the small dealer with the limited selection, the big organisation with a vast array of hi-fi, the enthusiastic assistant who will take you for a ride on his ‘comparator’, the man whose professional opinion is in sharp conflict with the story you heard from his rival down the road. If you persist you may reach the consultant type who is not only quietly knowledgeable but also lets you listen in peace.

Some retailers prepare typical combinations of equipment, ranging from low-budget to advanced hi-fi, and keep these ready for demonstration. This is a very sensible idea, and the assembly of a system in this way does not prevent the substitution of an alternative item at a late stage, once the buyer knows he is on the right lines as a result of a quick demonstration that is available without delay.

Another opportunity to sample stereo is provided by exhibitions—hot, tiring and sometimes confusing yet always fascinating. Sonex and the International Audio Festival and Fair are held in the London area in spring and autumn respectively, and similar shows have been held at Harrogate on several occasions. Sonex presents mainly component hi-fi and not very many really questionable items find their way into this show. The larger Fair is not intended to be a hi-fi exclusive and, although most of the big names in hi-fi are represented, the newcomer may be confused by types of product that are

difficult to classify (the old expression 'mutton dressed as lamb' may serve if nothing more technical comes to mind).

From time to time there are smaller shows that depend on the enterprise of individual manufacturing companies or retail concerns. In addition some retailers arrange hi-fi concerts either on their own premises or in suitable halls. A small concert can convey an impression of stereo as it works in domestic conditions; a larger one is more impressive and entertaining but is less immediately relevant to the needs of the buyer.

The visitor to an exhibition is likely to come away with a mixture of impressions. He can hardly fail to grasp the hi-fi conception and note the cost or acknowledge the manufacturers who, knowing what they are about, are so obviously at pains to put the music first—to let performance speak for itself. Other exhibitors simply make a lot of noise, hoping to attract the crowds. Shows of this sort are never ideal places for serious listening to every possible purchase: there is too much distraction, and some of the demonstration rooms are about as suitable as a railway station for a comfortable but concentrated audition. We can only hope that the methods of the more musically literate exhibitors will be noticed by the rest. It is true, of course, that a visit to an exhibition is worth while for technical reasons, for a show brings together many competing products and can aid the enthusiast who is revising his short-list.

Since the advice just offered started with a reminder to listen to music, it can finish with a warning about 'technical' tests. Resist the temptation to judge equipment with the aid of sine waves and other tones. These, the professional tester's tools, are for investigation of specific aspects of performance and most of them can be of value only if you are competent with test instruments. What you *are* listening for is the splendid realism of high fidelity—a natural, unspectacular quality of sound, full of detail and freely reproduced, good enough to remind you of the real thing.

7

AUDIO ACCESSORIES

ODDS AND ends of all kinds will be found on the shelves of the hi-fi showroom. Some of these are luxuries, some make for convenience or extend the uses of audio equipment, and some are essential for the correct functioning of audio systems. It is sensible to make a small allowance for certain minor items, the choice of which will depend on the user's interests and the fittings already provided on his disc or tape equipment. Such essentials as replacement styli and recording tape are not accessories in this context.

Starting with the necessary rather than the merely desirable, we must consider the pickup fittings, especially the lift/lower control which is so necessary for safe and sure handling of a lightweight pickup. Most integrated players and many separate pickups have built-in devices but a few of the least expensive arms are not so equipped. The control can be a simple device with a straight mechanical action or a more elaborate gadget with a damped action (Colton, Decca and others), and either type can be mounted beneath the arm tube. Most have some kind of horizontal rest or cueing bar which contacts the pickup arm. For the indulgent there is a Decca motorised device intended for remote control.

A bias (sidethrust) corrector is now regarded as an essential part of a modern lightweight stereo pickup. Most pickups have such a device, but it may be possible to obtain one in a very few instances where the arm was supplied without this fitting. The manufacturer should be consulted. There is no point whatever in trying bias correction on a heavy tracker or on a component that introduces excessive pivot friction. Setting-up checks—bias, tracking weight, tracking error—provides a subject worthy of detailed treatment, which is reserved for the next booklet in this series.

The pickup on an integrated player, of the transcription or any lesser type, will be fixed in position, and any adjustment will be restricted to the headshell in which there may be some provision for moving the cartridge to and fro. With all pickups, and especially when installing a separate pickup arm—and subsequently when changing cartridges—it is necessary to make a tracking-error check. Whatever the arrangement, the accessory is an alignment protractor (Howland-West, SME, etc.). Once the pickup is in use it is essential to remove any small accumulation of fluff gathering on the stylus, and a very small, soft brush is suitable. The kind supplied in a child's paintbox is suitable, but a special brush is included in the Schweizer range of accessories. Clean the stylus tip occasionally: use alcohol for stubborn encrustation or a cleaning kit (Metrosound, Bib) for mild contamination.

The calibrated tracking weight adjustment on a good pickup may in some cases be at least as accurate as anything provided by a separate check with a gauge. But still a balance or gauge will be needed in many cases. The device may be simple, cheap and accurate enough for the medium to high range, or it may have a much smaller margin of error, appropriate for setting-up operations with pickups that track at a gram or so. There is no point in talking about adjustments of $\frac{1}{4}$ gm. unless the method of measurement is very precise. Transcriptors, Shure and Colton are among the specialists.

There is a certain amount of controversy about record-cleaning methods—but no doubt at all that every day some expensive discs are damaged by over-enthusiastic cleaning. Methods may be selected according to the problems arising from dust and static electricity, but the first requirement is to keep

dirt away, thus avoiding the situation where rigorous and possibly damaging cleaning routines become necessary. It is safer to leave well alone than to apply methods that may have unpredictable consequences. Above all avoid cleaning preparations and any messy or abrasive methods if you are interested in high quality sound and maximum signal-to-noise ratio. However, there are appliances designed to discourage dust and tame static charges (C. E. Watts, Bib and others). Soft record-cleaning cloths are useful for gently removing large dirt particles (they do not, and cannot, clean grooves). The heavily impregnated kind of cloth comes under the heading of 'messy methods' and should not be used on discs from a hi-fi collection.

Other items include test and demonstration discs, stroboscope devices for use on a turntable that has no in-built strobe, anti-static mats for turntables (Colton, Metrosound), record and tape indexing aids, equipment cleaning cloths and lubricants, record wallets and protective outer sleeves, carrying cases and storage cabinets.

For the tape user who wishes to take a more active interest, perhaps by exploring the possibilities of creative recording, there are many editing aids including splicing tools, jointing tape and coloured tape. For maintenance there are kits of useful items (Bib, Metrosound, BASF, Philips, etc.) to speed such tasks as head cleaning. Although many users are not yet aware of the fact, the tape in cassettes can be withdrawn for editing or repair of breakage, and Bib have devised the accessories. There are also cassette tape-head cleaners—a standard cassette containing a soft tape which is run past the heads, removing deposits which are hostile to hi-fi frequency response. The same basic method can be used on conventional spool tape machines. Other items are head demagnetisers, remote controls and a large range of microphones from which the enthusiast can choose (highly directional, non-directional, moving-coil, ribbon) according to the nature of the recording and tape equipment.

Many users will already possess the tools and sundries that may be needed for audio odd jobs. Otherwise, outstanding items are a set of small screwdrivers, side-cutters or a wire-stripping tool, long-nosed pliers or tweezers, an instrument soldering iron and some resin-cored solder. The average enthusiast needs no reminding that the rest—odd plugs, tape, wire, screws and more screws—will accumulate with no apparent effort on his part.

8

LOUDSPEAKER LAB REPORT

TEST RESULTS on a group of loudspeakers first appeared in the July 1971 issue of *Hi-Fi Sound*. Examples of frequency response traces and impedance curves are included elsewhere in this booklet. Prices are those ruling at the time the report was prepared.

AR3a

Brief Specification. System: acoustic suspension. Drive units: 12in. bass, 1½in. mid-range, ¾in. hf. Power requirement: 25W rms per channel, minimum. Rating: sustained input of 11W rms at any frequency; 23W for at least 30 sec. Weight: 53lb. Dimensions: 25 × 14 × 11¼in. Distributors: Bell & Howell Ltd, Alperton House, Bridgwater Road, Wembley, Middlesex. Price: £178 in teak (other finishes available).

Comment. We were already familiar with this model. Renewing our acquaintance we think it sounds as smooth, 'flat' and lacking in intrusive personality as ever. Well integrated output, with plenty of detail and an unmuddled bass that is as good as we would expect from such a compact system. It is inefficient and needs a big input. Low distortion is obvious at first hearing. In fact the measured figures were 1.8% at 50Hz with low readings, not exceeding 1%, elsewhere in the range—the manufacturer's published data are evidently realistic. The AR impedance curve shows a 4-5 ohm average with a rise to 20 ohms at 45Hz. Our lowest measured figure was 3 ohms. Frequency responses are with controls at maximum setting (upper trace) and mid-position. Note the downward trend of the upper range. Even if it is beginning to sound marginally dated, it is still a very good loudspeaker, though frighteningly expensive.

JBL 4310 CONTROL MONITOR

Brief Specification. System: vented system, tuned to 28Hz. Drive units: 12in. bass (free-air resonance 27Hz), 5in. mid-range, 2in. hf. Crossover 1,500 and 7,000Hz. Frequency response: 30-15,000Hz ± 3dB, on axis. Impedance: 8 ohms nominal. Power handling: a 35Hz sine wave at 50W produces not more than 1% distortion. Distributors: Feldon Recording, 126 Great Portland Street, London W1. Price: £140 in grey finish. Domestic version at same price.

Comment. Designed to be at its best with pop music programmes with their bass emphases and colourful mid-range sounds. We have heard both this system and the bigger monitor in studios and acknowledge their merits in such environments. At home the 4310 sounded too bright and hard (mid-range control only mid-way) and very coloured, though revealing of detail; and on all non-pop sound we felt cheated of bass. The speakers accept hard use, as is to be expected. They exhibit very high subjective efficiency for high-level playback.

The response trace (one each for controls at minimum, mid-setting and maximum) is somewhat unconventional, lacking in extreme highs and lows, but there is an obvious 'presence' effect, recognised at first hearing. Distortion better than 1% at the worst point and exceptionally low through the range. A 'power-house' speaker, well suited to hard rock!

B & W DM3

Brief Specification. System: total enclosure with membrane Q controller. Drive units: bass unit 13 × 8in. with laminated glass fibre cone, plus Celestion hf unit and STC ultra hf. Frequency response: better than ± 5dB, 40-25,000Hz. Power handling: 15W rms. Impedance: 8 ohms nominal. Dimensions: 28½ × 15¾ × 11½in. Weight: 53lb. Manufacturer: B & W Electronics Ltd, Littlehampton Road, Worthing, Sussex. Price: £63, teak or walnut (other finishes available).

Comment. Tests were made with the hf control 'on' and the level control at mid-position. We measured 5% distortion at the extreme bass end; the figures were very low elsewhere in the range. The frequency response trace is pleasing—as smooth as the speaker sounds. Observe the impedance rise in the mid-range, where it is required to push in the power. In this connection note that the speaker is rated at 15W, so it is a partner for medium-weight hi-fi rather than the most potent of today's systems.

The DM3 is well established but still looks and sounds good against the competition. Its outstanding virtue is the smooth middle and top-end sound, evidence of wise choice of treble units and attention to crossover filters. Upper bass too fulsome at times but susceptible to control by placing the speakers on tables or plinths (accessories are available). Stereo presentation stable and realistic and there should be no positioning problem from *this* point of view.

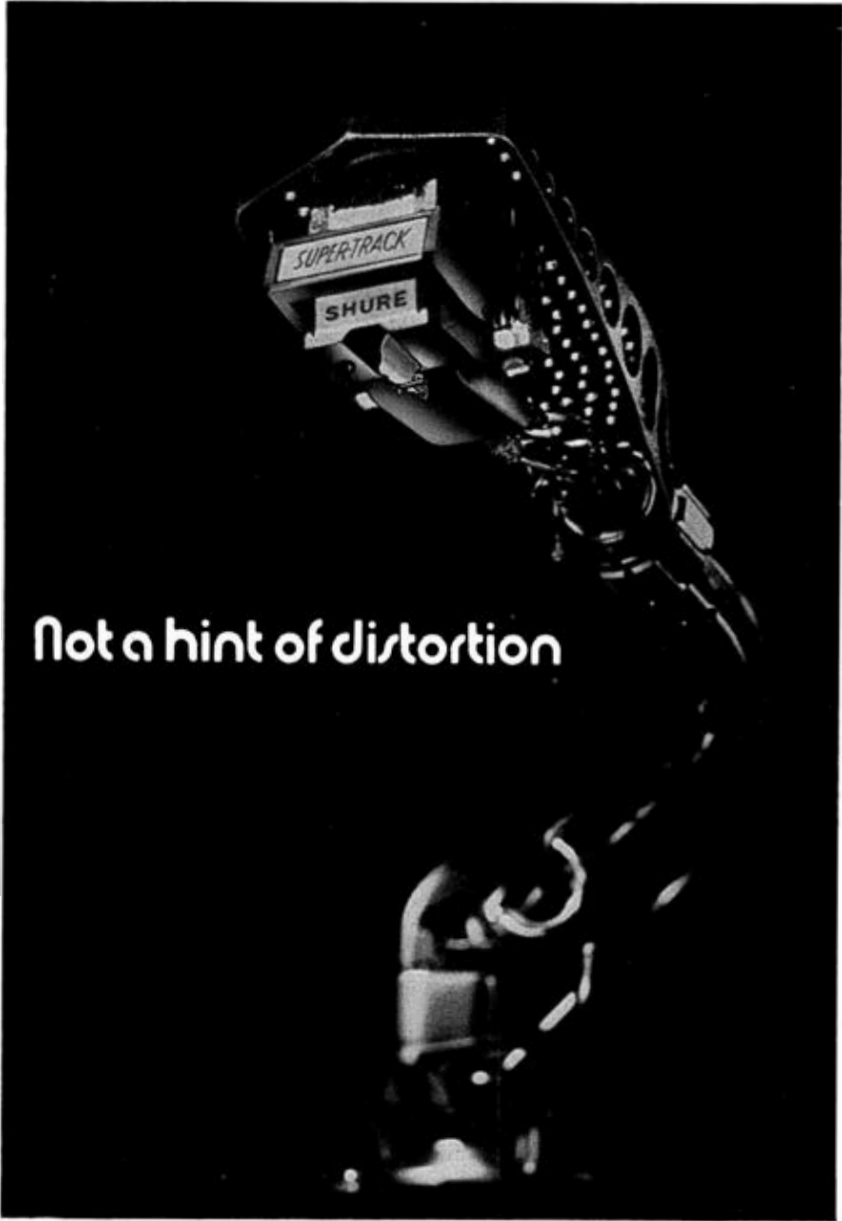
DYNACO A-25/11

Brief Specification. System: Aperiodic, with friction-loaded vent (acoustic resistance). Drive units: 10in. bass and two hf units. Crossovers: 1,500 and 8,000Hz. Impedance: 8 ohms nominal. Rating: 35W short-duration sine-wave signals. Distributors: Howland-West Ltd, 2 Park End, South Hill Park, London NW3. Price: £32.

Comment. Tests were made with the control in the normal position. Distortion about 10% in the extreme bass (it is curiously difficult to reconcile this with what is heard) but less than 1% through the rest of the range. The impedance curve is a reflection of very effective damping at the low end and lends support to the makers' claims. It also helps explain why the speaker can be driven to high levels successfully.

We liked this simple but effective design. A pair of A25's sound surprisingly 'big' as a stereo source, so that we have come to view the speaker as a miniature monitor. With a pleasing treble/bass balance and ability to accept large inputs, this speaker is one of the better 'compacts'. The sound is remarkably honest and the superior stereo presentation is in accord with the facts indicated in the polar response.

Also included in the original laboratory report were: KEF Cadenza, Wharfedale Dovedale III, Leak 300 and Celestion Ditton 120.



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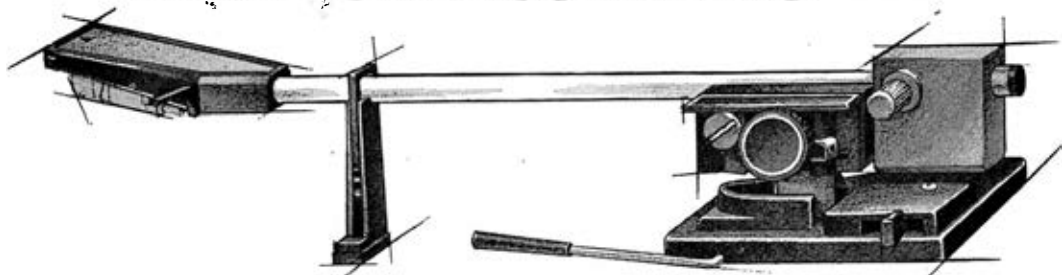


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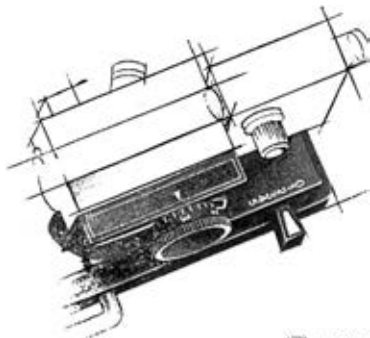
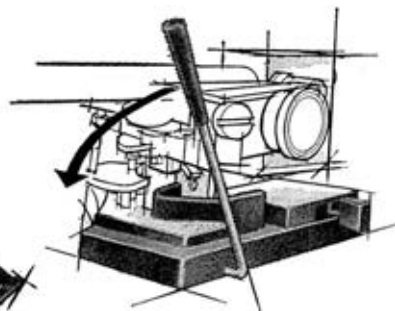
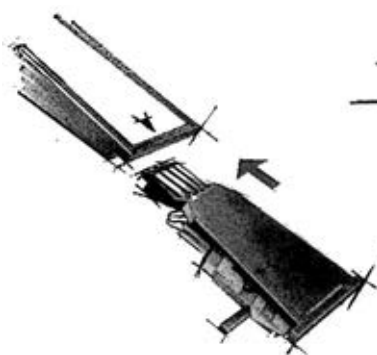
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- 10½ inch non-magnetic turntable.
- 4-pole induction motor.
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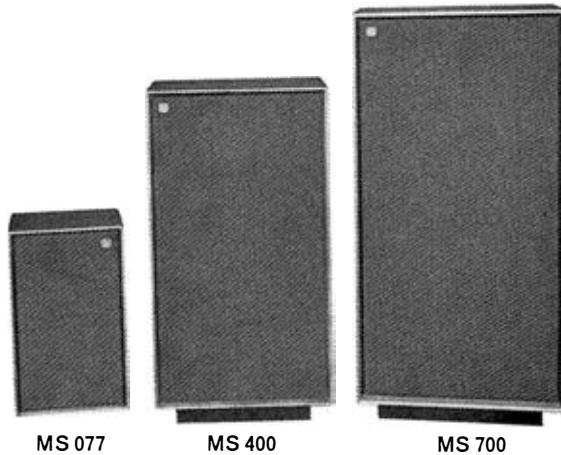
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2 x 8 watts into 8 ohms
Music power:
2 x 12 watts into 8 ohms
Harmonic Distortion:
2% at 2 x 6 watts
Frequency range:
60-20,000 Hz ± 3dB
Tone Controls:
Bass: +14 to -18dB at 50Hz
Treble: +12 to -13 at 10KHz
Scratch filter:
-6dB/octave
Rumble filter:
-6dB/octave
Signal to noise ratio:
> 55dB
Channel separation:
> 30dB at 1KHz
Input sensitivity—Tape:
230mV into 500K ohm for
8 watts output

TUNER

Wavebands:
LW 150-260KHz (2000-1154m)

MW 525-1605KHz

(511-187m)

FM 87.5-108MHz

Aerials:

Ferroceptor for MW and LW

(socket for external AM

aerial and earth)

IEC socket for FM dipole

aerial

Sensitivity:

A.M 25µV for 26dB signal to

noise ratio

FM 8µV at 15KHz deviation

1.5V at 40KHz deviation

for 26dB signal to noise ratio

across 300 ohms

Selectivity:

A.M 20 x for 9KHz off

resonance

F.M 30 x for 300KHz off

resonance

Distortion:

< 4% at 75KHz deviation

Pilot frequency

suppression:

-24dB at 19 and 38KHz

Audio response:

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de-emphasis

RECORD PLAYER

Chassis:

GC008

Turntable:

10" diameter

Speeds:

33 1/3 and 45 r.p.m.

Wow and Flutter:

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Rumble:

-38dB (DinA)

-58dB (DinB)

Pick up:

GP213 1/2" ceramic cartridge

Stylus pressure:

2-4g (calibrated adjustment)

Dimensions:

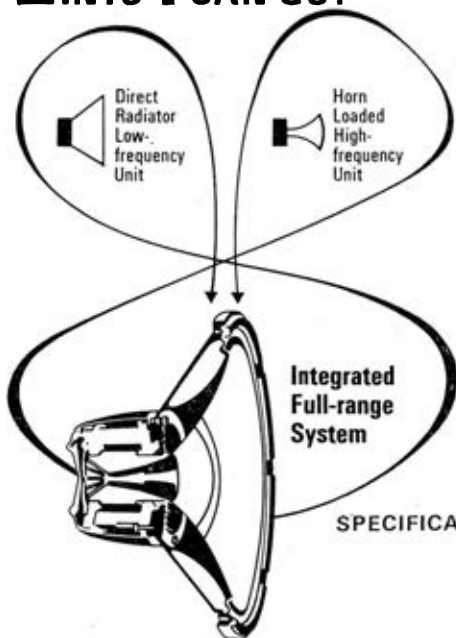
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21 1/2" x 6 1/2" x 11 1/2"

Weight:

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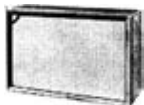
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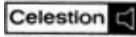
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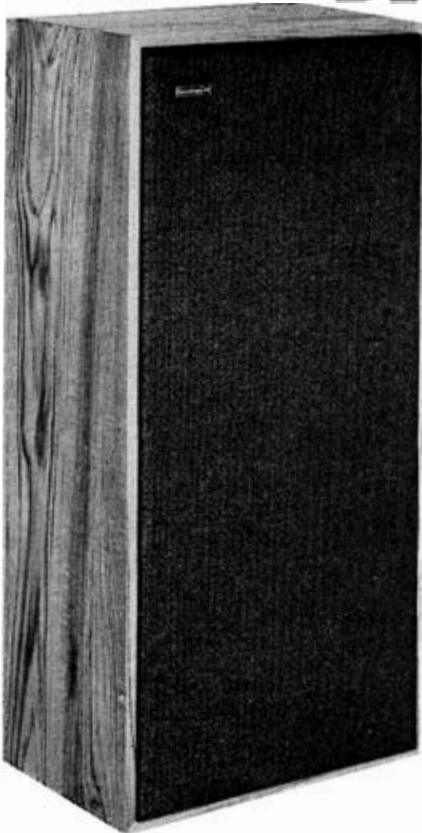
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MONITOR



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