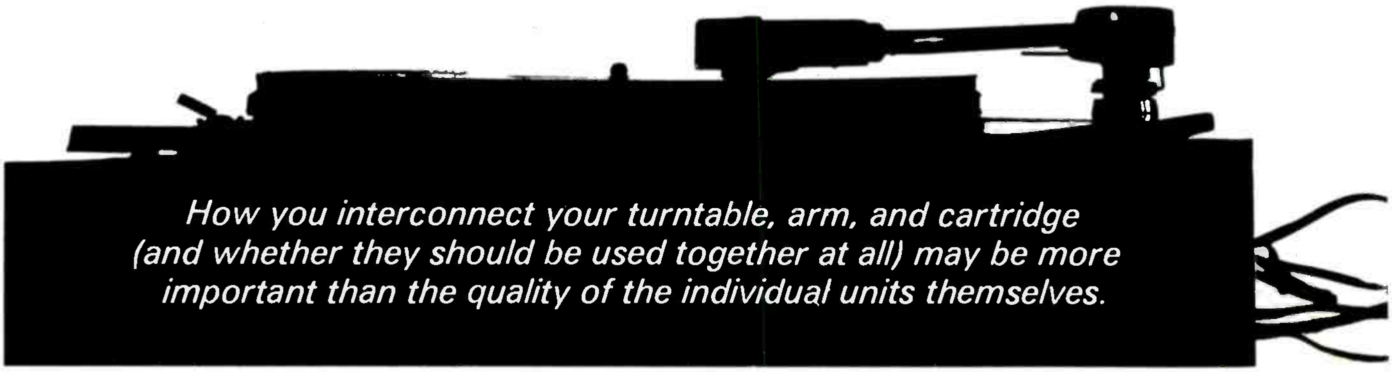
by John S. Wright



How you interconnect your turntable, arm, and cartridge (and whether they should be used together at all) may be more important than the quality of the individual units themselves.

Are Your Record-Playing

IT IS COMMONLY HELD that a high fidelity system is only as good as its weakest link, and audio enthusiasts argue the merits of this product over that, one phono cartridge over another, brand X loudspeakers over brand Y. Yet with all the knowledge many audiophiles possess, they frequently overlook a most important aspect of the *complete* system: Quite often the weakest link is not among the components themselves, but rather in the way they are linked to one another—or indeed their suitability to being linked together at all.

The person who buys a complete and integrated compact system often obtains a hidden advantage over one who compiles his own from separate components. If the manufacturer knows his job, the complete compact system should be perfectly matched and tailor-made to function as an integrated whole even though each component may be inferior to its separate counterpart. Putting together one's own system presents many pitfalls. It simply is not enough to select each component on its individual merits and hope that they all function at optimum when hooked together. Compatibility is an essential, if hidden, link in the audio chain and as such may well determine the final performance of the system.

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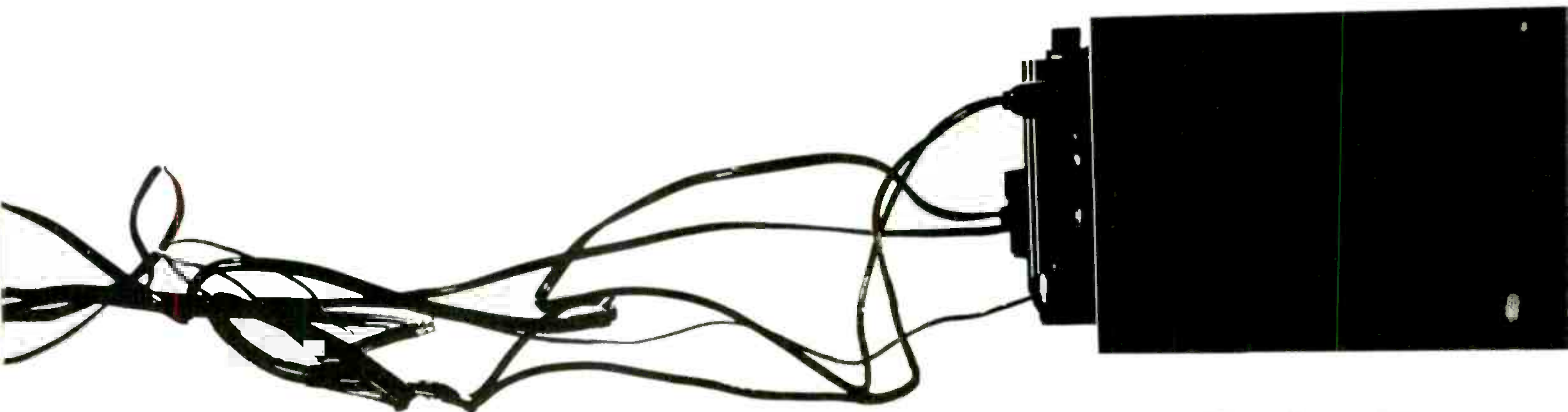
These pitfalls abound particularly in disc-playback equipment. What could be easier than fitting a cartridge to the end of a tone arm? However, if the compliance of the cartridge does not suit the arm, the combination may be disastrous. It is not generally understood that a tone arm can be of too low a mass for some cartridges, although arms tend rather to have too much effective mass for the average cartridge. The weight of the cartridge plus the *effective* mass of the arm creates a resonant system with the springiness or compliance of the stylus assembly. This results in a resonant frequency similar to the bass resonance we are accustomed to experiencing in loudspeakers. What matters is the frequency at which this resonance occurs and its severity—that is, its "Q."

The only thing we can hope for is to place the resonance out of harm's way; we cannot abolish it. It must be below 20 Hz where no musical information can trigger the resonance, but if it is too low—roughly in the ½-to-6-Hz range—we come into a region where it might be excited by disc warps and eccentricity. Furthermore we do not want it to manifest itself anywhere near turntable rumble frequencies. We are left, then, with a quite narrow band of frequencies at which this mass/compliance resonance may safely occur—say, between 7 and 14 Hz.

To predetermine the frequency of this resonance



Components Compatible?

it is necessary to know the effective mass of the tone arm—the actual moving mass as seen by the stylus—and the *dynamic* compliance of the cartridge. What is usually quoted by cartridge manufacturers is the *static* compliance, which is not necessarily the same thing at all because the dynamic compliance varies with frequency. So try to find a manufacturer who quotes the effective mass of a tone arm or the dynamic compliance of a cartridge, then take a degree in physics and math, and you can start to find the ideal arm/cartridge combination in respect to compatibility. Obviously impractical? Then only experience can be the guide, and a really sincere audio dealer can give advice that adequately justifies his profit margin.

For most cartridges tracking between ¾ and 1½ grams and weighing some 7 to 8 grams, an effective arm mass of, say, 10 grams places the stylus compliance resonance at about 10 Hz, giving plenty of margin each way. Of course, it is necessary to know the effective mass of the arm actually in use; for example, the Shure SME 9-in. Series II arm has an effective mass around 10 grams; the Thorens TP-13 arm and that on the Garrard Zero 100 changer are only slightly heavier at about 12 grams; the Ortofon RS-212 is much higher at about 17 grams though the AS-212 measures only 13.5 grams. Among the arms with higher mass are the Sony PUA-237 at 28 grams and that on the Lenco L-75 turntable at 23. These figures represent the arms set for use with a cartridge weighing 7 grams and were measured using a vibration and mass substitution method.

Too high an effective arm mass produces excessive cantilever movements, accompanied by the "watery" effect of Doppler distortion or even partial loss of groove contact on the fall of record warps. This may also cause "cone-weave" on all but infinite-baffle types of loudspeakers. These subsonic disturbances unnecessarily absorb amplifier power and possibly overload some early electronic stages. (For this reason there is much to be said in favor of an amplifier's having a sharp cutoff below 20 Hz, but most do not.) If the arm and cartridge combination has too *low* an effective mass, the resonance frequency will rise and the bass response may become overemphasized. Whether the resonance is too high or too low, the resulting tracking problems can be only somewhat alleviated by increased stylus tracking force.

Arm Damping Fact and Fancy

Allied to the problem of compatibility between mass and compliance is the critical damping of arm and cartridge—damping being the inhibition of spurious motion or oscillation. Most cartridges incorporate a degree of low-frequency damping within their construction. However many cartridges may have inadequate damping for proper results with the particular arm employed. Few tone arms incorporate the additional damping to optimize results. The significant advantage of a damped arm over a nondamped type is that this feature lowers the Q of the arm-mass resonance while generally stabilizing tracking. It also provides a considerable degree of isolation against acoustic feedback and external shock. It is virtually impossible to overdamp an arm in this respect, and because of the often inadequate cartridge damping itself, increasing that of the arm always is an advantage. One of the simplest and most effective ways of doing this is to pack the bearings with a stiff but compliant grease, such as a silicone, in manufacture. Why don't more manufacturers employ this simple solution? Perhaps it is because it makes the arm feel stiff, which would give the novice the impression of excessive bearing friction.

Some people mistakenly think that a small amount of arm pivot friction can be a substitute for damping—or even for bias correction. This is, of course, nonsense. Should pivot friction be used this way, major force would be required to get the arm into motion from stationary; true damping requires negligible force to put it into motion—the damping's effect is inversely proportional to velocity. It remains essential to keep arm friction as low as possible if the pickup is to follow the undulations of the disc easily and precisely. It is enlightening to note that if records could be made perfectly flat and perfectly concentric, there would be little need to worry about tone arm friction, mass, or damping.

The characteristics of the turntable and its mounting may further add to the troubles caused by mismatch between arm mass and stylus compliance and the inadequate damping thereof. All turntables rumble more or less, and the frequency of these rumble components (and their amplitude) determines the "annoyance value" of the rumble. Due to the way our hearing varies in sensitivity with frequency and intensity, rumble in the hundreds-of-Hertz region is far more obvious and unpleasant than rumble at lower frequencies. Thus an equal amount of rumble energy from two turntables may result in distinctly different subjective results if one set of rumble components is at a higher frequency than the other. (This phenomenon is the basis of the ARLL—Audible Rumble Loudness Level—measurements provided for HIGH FIDELITY test reports by CBS Labs.)

Don't be misled, however, into assuming that the lower the rumble frequencies, the better. It is not quite that simple because if the rumble frequency is too low it may appear in the frequency band where arm resonances occur and result in the generation of intermodulation. At worst it could cause pickup instability, mistracking, a tendency to set off room resonances resulting in acoustic feedback, and accentuate the rumble. Thus a turntable acceptable for one tone arm, cartridge, and ancillary combination may not be as well suited to another.

While ARLL and other "weighted" (or frequency-selective) methods of measuring turntable rumble are fine for expressing subjective rumble level, they do not take up the compatibility problem as such for two reasons. First, the frequencies at which rumble and arm resonance can act cumulatively are below audibility and therefore usually are minimized by the weighting curve. Second, the resonance of the arm-and-cartridge combination will depend on both elements, and resonance of a cartridge must be measured in *some* arm (but not necessarily in the arm that you would use it in) while arm resonance can only be measured with *some* cartridge. Published resonance figures for either a pickup or an arm, therefore, are a guide rather than an absolute in determining the compatibility of a prospective component mix. HIGH FIDELITY, for example, normally measures all cartridges in the SME arm, all arms using the Shure V-15 Type II Improved cartridge.

Manufacturers are of course aware of the considerations we have been talking of. They might have ameliorated the problems involved by integrating arm and pickup—rather than arm and turntable—at the design stage, but the public has demonstrated a distinct distaste for mounting arms on separate turntables. Be that as it may, cartridge manufacturers must design for arms built by other companies. But often the literature for these "universal" cartridge lines now (and fortunately with increasing regularity) specifies the equipment with which the cartridges are to be used. These recommendations are not to be taken lightly. In suggesting that cartridge A be used with arm B but not with arm C—or with changer D but not integrated turntable E—the manufacturer is allowing for the very compatibility factors that we are discussing here.

Akin to the problem of turntable rumble is the manner in which the unit is mounted. All forms of rumble are minimized by mounting the turntable solidly on a high-mass motorboard and, better still if possible, affixing the unit directly to the structure of the building. But from a commercial viewpoint this is quite impractical. Most manufacturers choose to suspend their turntables on springs in an attempt to isolate them from feedback or mechanical shock. This type of mounting can cause problems of its own, however. The mass of the turntable together with the compliance of the mounting springs again establishes a resonant system, with a frequency that accidentally may coincide with that of the arm resonance, rumble components, a loudspeaker, or room resonance—or even all of these factors at once. I have frequently encountered these very problems, which cause loudspeaker cones to oscillate at near DC conditons, totally spoiling the reproduction from the system as a whole. Many users suffering from these coincident conditions seem totally unaware of the cause and blame almost any component in their system except the turntable mounting springs. If the springs of a turntable have to be used (it is usually possible to disable them without harmful effects), they should be well damped with sponge rubber so that the Q of this resonance is low. Pieces of foam rubber, such as that used in upholstery, can be stuffed into the springs for this purpose; in some installations the adhesive-backed foam rubber strips intended for weatherstripping can come in handy. Properly treated, the springs will act only momentarily when they really have to and are not continually in motion at the least provocation. Surely the time has come when we can hope that more turntables will employ sophisticated suspension arrangements, such as oil-filled dash pots or self-damping cantilever supports.

So much for "simply" fitting a cartridge to an arm and turntable.

And So, to the Preamp

The next step is to plug the leads from the tone arm into the preamplifer. Also simple? Of course, but the present trend toward greater stylus compliance and lower tracking forces unfortunately leads to lower cartridge outputs. To raise output once again, cartridge manufacturers usually apply more turns of wire to the coils raising the cartridge inductance. Not only can this increase hum pickup problems unless adequate shielding is employed, but it also affects the *electrically* resonant circuit formed by the inductance of the cartridge combined with the capacitance of the interconnecting cables (plus the input capacitance of the preamp). Like the aforementioned resonances this one too is unavoidable, and all we can do in this case is hope to place it well *above* the audio bandwidth. It should if possible avoid coinciding with the frequency of the stylus' tip-mass resonance, which will cause a peak in the high-frequency response and usually is accompanied by ringing and a response that falls away rapidly above the resonance. This phenomenon takes on particular significance if we are to expect four-channel playback from disc via a multiplex system with an extended bandwidth out to 40 kHz, requiring high-frequency resonance to be that much higher.

In any case, for normal two-channel playback it is necessary to keep the cable capacitance as low as possible (say, below 125 pF to be practical) if we expect to realize the manufacturer's specification, usually quoted into a purely resistive load of 47,000 ohms. Moreover the preamps built into many amplifiers do not present an ideal load—a fact easily documented by testing their response with a cartridge of known performance characteristics. In general, the higher the inductance the more the cartridge will be affected by changes in load termination. Thus unduly long pickup cables of high capacitance can degrade performance. Again, few manufacturers bother to quote lead lengths and capacitance per foot, so if in doubt replace the wires provided with the shortest possible lengths of high-quality (lowest-capacitance) shielded cable.

The comparatively low outputs of recent cartridges have also led to even more sensitive phono input stages, figures of 1 or 2 mV becoming more common. Some amplifiers feature facilities for alternative input sensitivities. You may think on first consideration that the more sensitive the phono input the better so that the preamplifier will be sensitive enough to accommodate *any* cartridge the user may eventually choose. The hidden pitfall of this philosophy is that, with conventional input circuitry, increasing the sensitivity also reduces the peak voltage the amplifier input can accommodate without overload. Although the best magnetic cartridges rate their outputs as only a few millivolts, this measurement is based upon readings taken while playing low-level test discs. Under actual music conditions peaks between 30 and 50 mV are not uncommon even from relatively low-output pickups. No matter what the preamp's phono input sensitivity then, the overload margin must be at least 40 mV and preferably should approach 100 mV. For example, a cartridge rated at 6 mV output (for 3.54 cm/sec. groove velocity at 1 kHz) would be well suited to a preamp rated at 6 mV input sensitivity, with an overload point above 50 mV. Some cartridges give over twice the output of other cartridges and make even greater demands on a sensitive phono input. Depending on design therefore, ultrasensitive inputs might be a mixed blessing. It is expedient to see that the phono input matches the cartridge not only in terms of impedance, but in input sensitivity and overload margin as well. Many pickups have been blamed for "mistracking" that ultimately has been diagnosed as input overload.

Canny diagnosis is in fact the key to achieving compatibility among your record-playing components. In no other area of stereo equipment are the variables so diverse and yet so complexly interrelated. This is why the pertinent performance data (for resonance frequencies, amplitudes, and the rest) are both difficult to find for some products and difficult to interpret precisely for almost all products. But even if the specs help you decide in advance which components seem to be most compatible, there is no substitute for actually trying them together—preferably in your own room. ■