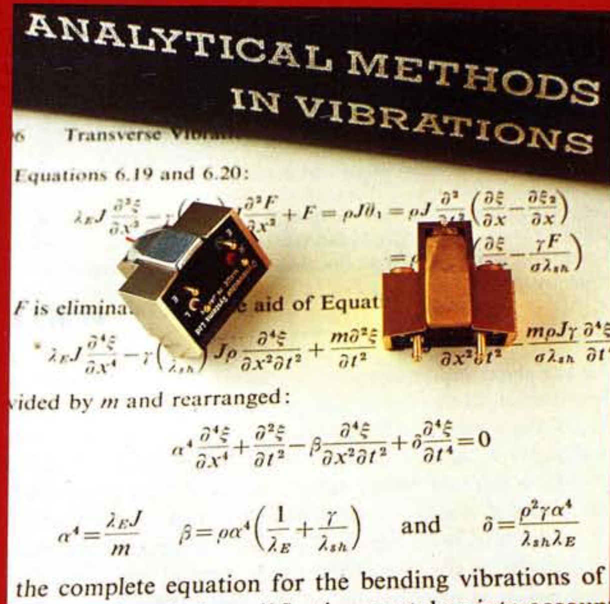
Dynavector



DV-KARAT DIAMOND
DV-KARAT

Dynavector Systems, Ltd.

General description

Dynavector cartridges are now enjoying very good reputation and reviews in the world for their impeccable musicality in addition to the remarkable technical performance. The principle of the Dynavector products is that the music in the records should not only be reproduced with ultimate high fidelity but also with the excitement which the real musical performance contains.

Our designers and engineers are all real music lovers and know the real sound of music very well as well as the reproduced hi-fi sound from many top quality hi-fi equipments in the world. Our products must pass the hearing test as well as the strict technical measurements. The standard monitoring system in our company is the very huge and high efficiency loud speaker system as shown by the picture.

This system can deliver 125 dB sound pressure with only 100 watts from 5 HZ to 40 kHZ. With this system we can identify the every detail in the performance of the equipment under test. After long testing experience of many products including our products, prototypes and other maker's products, we have noticed some puzzling problems in the evaluation of the cartridges.The frequency response of today's top quality cartridges whether they are moving magnet (MM) or moving coil (MC) is remarkably flat and wide range.

But actual sounds reproduced by these cartridges are not equal with each other. Even the transient response to the square wave seems to be independent with each other. These peculiarity is solved only by the concepts on which the design philosophy of DV/KARAT is based.

These purely theoretical investigations for the cartridge design concluded the unprecedent or unusual design criterion. This criterion needs the very short length and the very hard material in the cantilever design. But this criterion was found to be absolutely the truth after we have listened to the reproduced sound by the prototypes of DV/KARAT. In all respects, the sound by DV/KARAT is outperforming the sound quality of the cartridges designed by the traditional design concepts.

This innovative design concepts were recognized by the CES CHICAGO in 1979, and DV/KARAT was selected as the winner of the award of DESIGN AND ENGINEERING in this exhibition.

We were already given the same award from CES by our products in the past two years, that is, by DV/505 bi-axial and dynamically damped tone arm in 1977 and the DV/10X high output moving coil cartridge in 1978.

In addition to these honors, DV/KARAT will be given the honor as the pioneer of the new generation of the cartridges with the more advanced design concepts.

Picture

Theories behind the design of DV/KARAT/DIAMOND.

As partly described above, the today's top quality cartridges are designed to follow the criterion of the frequency response to be as flat as possible in the wide frequency range.

Not a few cartridges whether they are MM or MC have attained this criterion by their clever design. But the sound characters by these cartridges are embarassingly different with each other. By the conventional theory, the very flat frequency response with very wide bandwidth means no deformation or variation of the wave forms in output signals. But there exists the evident difference in sound character from one cartridge to another. It is true and can be analysed theoretically that the performance of MM cartridge is virtually different from the one of MC cartridge because of an additional time constant in its characteristic equation of the transfer function, and this results in the difference of the sound quality between MM and MC cartridges. But it seems to be very puzzling to find that the high performance MC cartridges have their own sound character even though the technical data are quite similar with each other.

These condition could be partly explained by the difference in damping rubber material, cantilever material and stylus shape. But they are not straight forward or fundamental. By facing these actual difficulty, the conventional design theory of cartridges is thought insufficient and too much optimistic for designing the top quality moving coil cartridges.

In other words, more exact and precise design concepts are needed to settle these confusion.

After many reviews of today's design theories for cartridges, we were required to reconsider the physical conditions of the cartridge from the more fundamental point of view. The most of design theories of today's cartridges are either the electro-mechanical simulation method or matrix algeblaic method which starts from the simpler vibration theory.

By the former method, the vibration system like a cantilever of a cartridge is considered as being comprised of many cascaded small segments like a ladder. Each segment is represented by the simple electro-mechanical analogy of resistance, capacitance and inductance which forms a simple electrical circuit. Interconnecting these simple electrical circuits makes the complex network, the performance of which is similar to that of the actual mechanical system. This is the simulation method and this method is quite common to the electrical engineers. With this method, the detailed discussion relating to the frequency domain becomes easy. On the other hand, by the matrix method, the detailed consideration of the flexural modes of the bending vibration of a cantilever is possible. Above two methods are effective to consider the steady state of the vibration of a cantilever, but no information of the wave propagation along the contilever is available by these approximation method. To avoid these difficulties, we have started from the next most rigorous vibration equation of a bending vibration of a cantilever in order to have more detailed aspects in this problem.

$$\frac{EI}{m}\frac{\partial^4 y}{\partial x^4}+\frac{\partial^2 y}{\partial t^2}-\rho\frac{EI}{m}\left(\frac{1}{E}+\frac{\gamma}{G}\right)\frac{\partial^4 y}{\partial x^2\partial t^2}+\frac{\rho^2\gamma}{mG}\frac{\partial^4 y}{\partial t^4}=0\cdots(1)$$

Here,

E : Young's modulus

I : secondary moment of section area

G : shear modulus

m : mass per unit length of a cantilever

ρ : density of the cantilever material

x : distance from the end of the cantilever

y : flexural displacement of the cantilever

r : constant

t : time

From this equation, the propagating velocity C_B of a harmonic sinusoidal wave of the frequency f is calculated as following,

$$C_B=\alpha\sqrt{2\pi f}\left[1-\frac{1}{4}\beta\frac{2\pi f}{\alpha^2}+\frac{1}{4}\delta(2\pi f)^2+\cdots\cdots\right]\cdots\cdots\cdots\cdots(2)$$

Here,

$$\alpha^4=\frac{EI}{m},\quad \beta=\rho\alpha^4\left(\frac{1}{E}+\frac{\gamma}{G}\right),\quad \delta=\frac{\rho^2\gamma\alpha^4}{EG}$$

This is the most exact analytical solution for the wave propagation velocity taking into consideration of the rotary and shear effect in the bending cantilever. Even if these effects are ignored, the propagation velocity is calculated, as,

$$C_B=\frac{2\pi}{\lambda}\sqrt{\frac{EI}{m}}\cdots\cdots\cdots\cdots(3)$$

Here,

λ : wave length

As shown by these analysis, the wave propagation velocity along a cantilever is obviously not constant but changes inversely as the wave length. A nonharmonic flexural pulsive signal may be regarded as consisting of a superposition of harmonic waves of different wavelengths.

Each of these waves has a different propagation velocity, so it follows that a flexural wave of arbitrary shape like in a musical wave form picked up from the record surface cannot propagate along a cantilever without DISPERSION, which results in a change of the wave shape in the output. A medium exhibiting a wave velocity $C_B(\lambda)$ depending on the wavelength is called a DISPERSIVE MEDIUM. The only flexural wave form propagating in a uniform cantilever without altering its shape is the simple harmonic wave.

As described as above, it is inevitable that the musical signal is deformed by its propagation along a cantilever as long as the transverse or bending motion is used for picking up the signal from records surface like in the today's phono cartridges. In the most cases today, the physical constant E/ρ which means the propagation velocity of the longitudinal wave in the medium is considered as the one of the measures for evaluation of the cantilever in a phono cartridge.

But this velocity has nothing do with the vibration of a cantilever, because the cantilever vibrates only in bending or transverse direction not in longitudinal. As shown by (2) or (3), the propagation velocity can be improved by the larger constant of E which is the strength of cantilever material and the larger number of I/m which means that the profile of the section of the cantilever is the important factor. The fastest cantilever is considered to be the one having the large diameter and thin wall of the very hard and very light material. When the very light

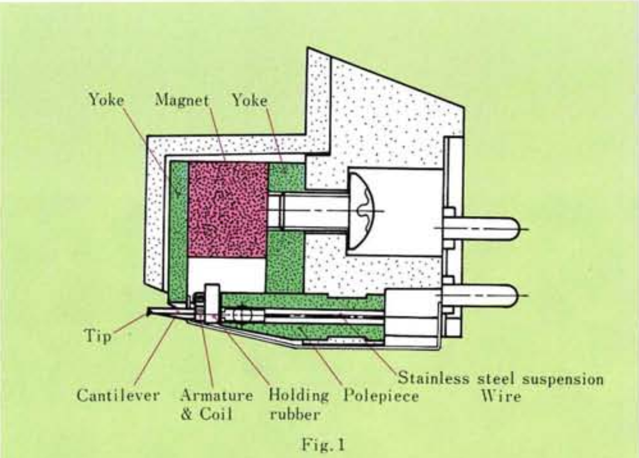
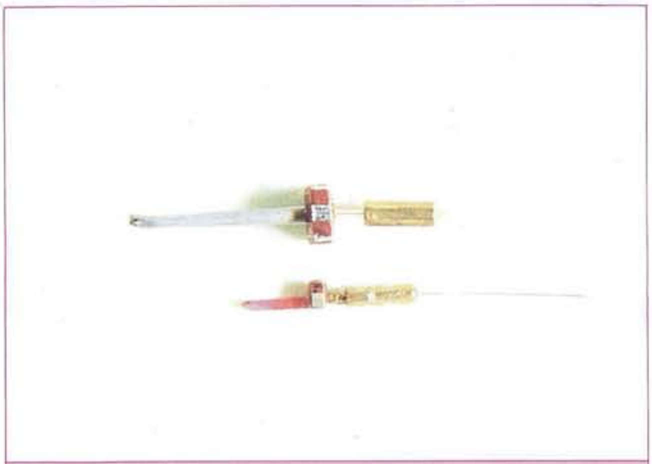


Fig. 1

cantilever of smaller diameter is used in the design attempting to have the very small equivalent mass by which the resonant frequency can be very high, the propagation velocity is not so much improved even by the very light and hard material used.

Unfortunately the most of the up-to-date high quality cartridges are designed by the criterion of the very wide frequency response with very high resonance frequency. The propagation problem is not particularly accounted or rather overlooked in their design. By these design the great number of frequency components contained in the pulsive signals disperse easily after travelling along a cantilever making the original pulsive wave form rather mild wave form losing some sharpness existing in the original sound. With these cartridges, we can hear the exessively smooth music from records, which seems to be very favourable sound. Yes, many audiophiles love these character of the reproduced sound, but we can never approve such sound character by our standard as the real music listener. In other words, the most important factor in the music, that is, the excitement of the real musical performance is more or less lost in these design. As long as we use the today's principle of the cantilever in the cartridge design, the most drastic concept to improve the propagation problem is the use of the far shorter cantilever by the very hard material.

We had experiments by designing the moving coil cartridge with the diamond cantilever of only 2.5mm length. The results were really treamandous and surprising. Every detail of the music in the record was more precise and had more liveliness and excitement as in the real music. Every instrument came closer to the listener out of the speaker boxes and they were positioned in the correct place. In addition to these outstanding features, the sound from the old timer records which are stocked in the library as the nuisance was found to be astonishingly fresh and exciting when reproduced by this prototype.



Picture 1

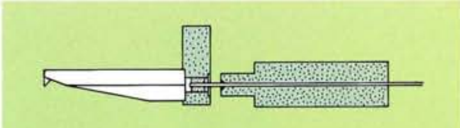
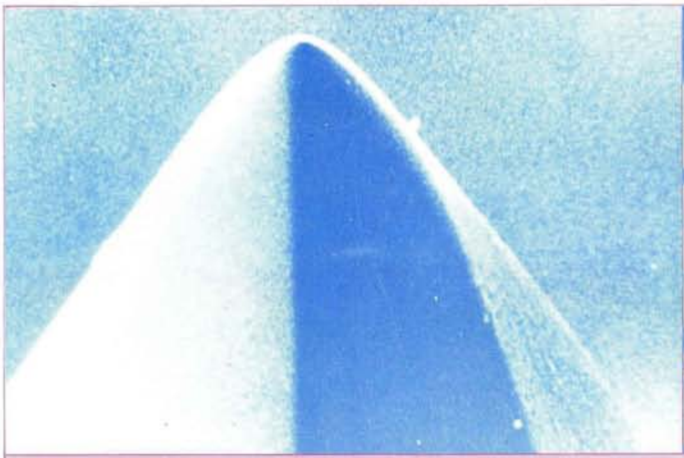


Fig. 2

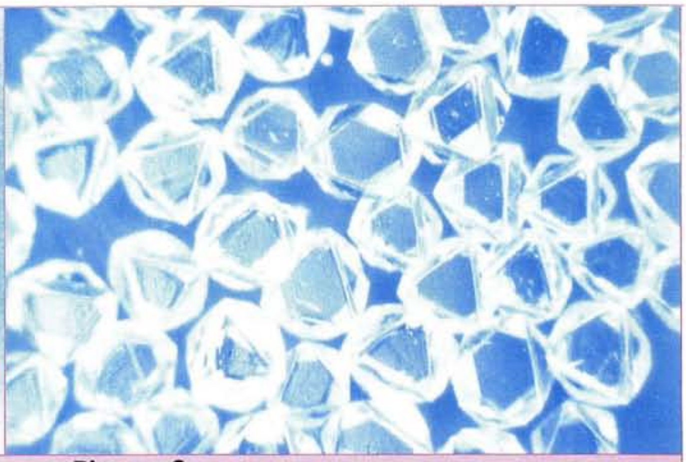
As mentioned above, DV/KARAT is just the answer of us to fulfill the most difficult desire which almost all cartridges could not satisfy yet although their technical specification looks very excellent.

By virtue of the unusually small size of DV/KARAT, the resonance frequency became very high exceeding 50 KHz, thus no damping action is needed within the frequency range from 20～50,000 Hz. The physical characteristics of rubber as the damping material are very complex, sometimes very embarrassing, to give the serious effects on the technical performance of the cartridge as well as on the musicality of that cartridge.

The damping coefficient of the rubber is regarded theoretically or practically not constant but affected more or less by the variation of the amplitude and the frequency of the signal. If the frequency response of the cartridge is flattned only by the excessive use of the rubber material, the sound quality of these cartridges is controlled by the characteristics of the rubber. In addition to these unfavourable character, the performance of damping rubber is seriously affected by the temperature. The most cartridges change their sound quality and tracking ability by the change of room temperature. On the contrary, in the structure of DV/KARAT the rubber material is used only for the suspension of a cantilever to avoid its upward leaning when playing records. This is not for the damping action, therefore, the sound quality and the tracking ability are almost not dependent upon the room temperature whether it is very cold or warm. The creeping time effect of the change of the rubber characteristics is also negligible.



Picture 2



Picture 3

You understand now why the philosophy and the construction of DV/KARAT are so different but outpurforming other traditional cartridges. Almost all old masterworks on discs by B.Walter, M.Callas, J.Heifetz, V.Horowitz, A.Rubinstein, L.Klauss, etc., etc., presumably sleeping in your library can revive and sound again with similar excitement and high fidelity like the modern direct cut records, sometimes with more natural ambience than today's hi-fi records.

DV/KARAT guarantees you to extend your enjoyment by record music to the extent of hearing the live musical performance.

Fig. 1 shows the construction of DV/KARAT

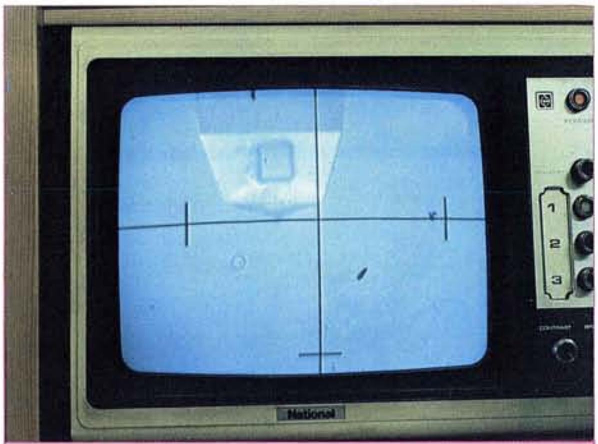
Fig. 2 shows the section of the cantilever

Picture 1 shows how the size of cantilever is smaller than the conventional cantilever.

Picture 4

Picture 5

Production of DV/KARAT/DIAMOND



Picture 6

Because the size of DV/KARAT is very small and the material of the cantilever is also unusual, every common knowledge for manufacturing conventioal cartridge becomes useless. We have decided before going into production of DV/KARAT to make the most use of the very advanced precision technology of NAMIKI PRECISION JEWEL Co. by the special agreement.

The stylus in DV/KARAT has the line contact shape of 0.1×0.1 mm size illustrated in Picture 2.

These styli are polished from the natural octahedron diamond grains as shown by Picture 3.

Diamond cantilever polished into the shape from the natural diamond shown by Picture 4.

Ruby cantilever is also cut from the artificially grown single crystal of ruby and polished as shown by Picture 5.

To avoid the dropping out of the stylus from the cantilever, a very small hole must be drilled to fit the stylus in it, but this drilling was long time wanted without success, but NAMIKI succeeded finally by the use of the YAG laser beam machining process. The laser beam machines the very small square hole of 0.1×0.1 mm size at the cantilever top as shown by the ITV Picture 6.

Picture 7. shows the cantilever with the stylus mounted.

The armature for the moving coil has very small size of 1×1 mm and the thickness is 0.5 mm. As shown in Fig. 2, the suspension device of this very small armature needs a extremely precision machining process. This process is only possible by the electric discharge machine shown by Picture 8.

After assembling the entire cantilever, the very thin wires are wound 40 turns per channel automatically by the special winding machine as shown by Picture 9. You can

DV-505 TONE ARM plus DV-30C

Picture 7

Picture 8

recognize how smail size is used in DV/KARAT compared to the ordinary moving coils by seeing Picture. 1.
The diameter of this wire is 11 micron meter and its material is silver.

The magnetic circuit is comprising the very strong rare earth magnet of light weight.

The body shell is made from the fibre grass reinforced polyester which has light mass but metalic hardness to ensure the better sound quality.

Picture 10 shows the assembled inside of DV/KARAT.

The small size as well as the light material resulted in total weight of 5.3gms, which is affordable to match with the most modern low mass tone arms.

Testing DV/KARAT

We beleive that the final testing measure should be by the indivisual hearing test, and the technical data obtained by the today's standard method is not paticularly thoroughly related to the result of this hearing test. But each piece of DV/KARATs is examined strictly by all the testing methods before delivery. This guarantees the quality and is regarded as the one condition to evaluate its performance. These test methods include frequency response, cross talk, second and third harmonic distortion, step response, tracking ability and intermodulation testing.

Frequency response

As a standard, we use B & K 2009 testing record for testing the frequency response from 20 to 20,000 Hz and this data sheet is attached to each cartridge before delivery. In addition to this record, we use JVC TRS 1005 for the frequency response from 1,000 to 50,000 Hz.

Picture 9

Distortion and cross talk testing

Distortion and cross talk characteristics are measured automatically with the harmonic tracking analyser and X-Y plotter. Fig. 3 is the typical frequency response of DV/KARAT from 20 to 20,000 Hz, and Fig. 4 is the one from 1,000 Hz to 50,000 Hz. Fig. 5 shows the cross talk and harmonic distortion characteristics of DV/KARAT.

Picture 11 shows these instrumentation.

Picture 11

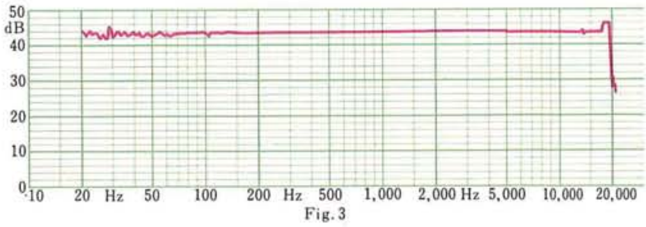


Fig. 3

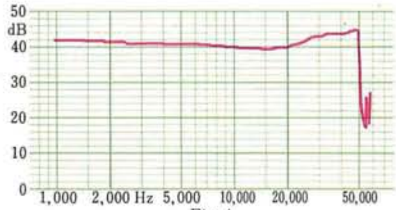
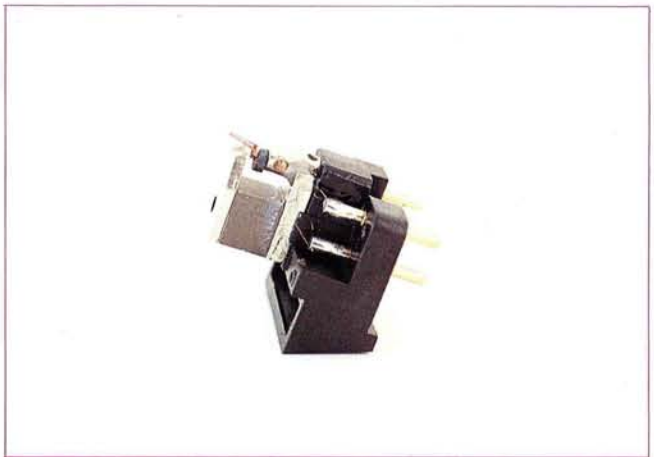


Fig. 4



Picture 10

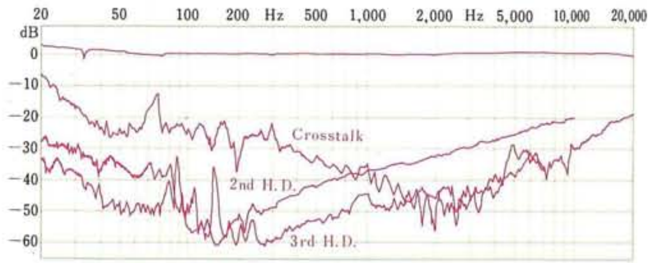
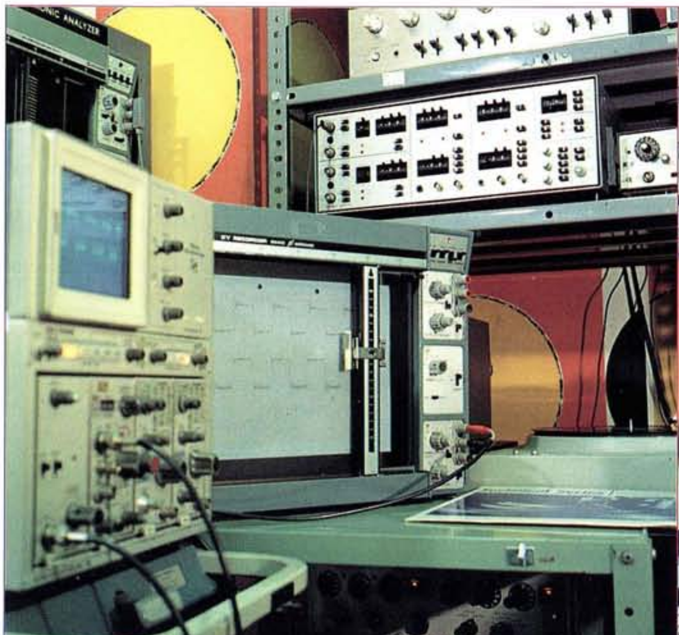


Fig. 5

Step response

If the dynamic characteristics of a cantilever is regarded as non dispersive medium, the step response and the frequency response have the correspondence of one to one. In DV/KARAT this dispersion is kept minimum, so the square wave response at 1,000 Hz of Fig. 6 could be a good measure for the frequency response.

By seeing this picture, you can recognize that the square waves recorded by the cutter head having the resonance at about 35,000 Hz are clearly reproduced with excellent details. There is no overshoot nor undershoot but only transients by the cutting head is observed in this picture with excellent repeatability. To record the square wave response, firstly the output voltage is memorized in the wave memory equipment of very fast response, then the memorized wave form is delivered to XY plotter very slowly but with very good precision. Picture 12 shows these instruments. In this case, the testing record is CBS STR 112.



Picture 12

Picture 13

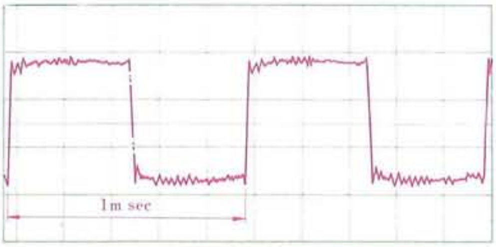


Fig. 6

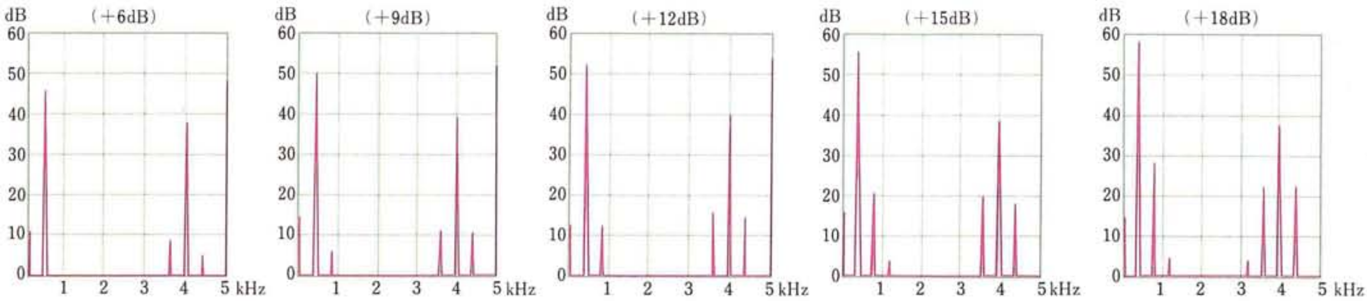


Fig. 7

Intermodulation distortion measurement

CBS STR 112 testing record is used to measure the intermodulation distortion. The output voltage of the cartridge playing CBS STR 112 is fed to the real time spectrum analyser which is shown in Picture 13.

The spectrum diagram on the screen of this instrument is hard-copied on the paper to make the calculation of the intermodulation distortion figure. Fig.7, a, b, c, d, e show the typical spectrum when 400 Hz plus 4,000 Hz are applied in the lateral direction to DV/KARAT in 6, 9, 12, 15, 18 dB excess state of 400 Hz component which is added on the constant 4000 Hz component. By this figures, the intermodulation figure of DV/KARAT is -30 bB at 6 dB, -27 dB at 9 dB, -23 dB at 12 dB, -20 dB at 15 dB and -16 dB at 18 dB. This intermodulation figure seems to be far better than almost all other cartridges whether they are M C or M M.

Conclusion

As obviously as described above, the DV/KARAT/DIAMOND is the products of innovative thinking. It is entirely the new generation of phono cartridges. Every detail which was missed by the traditional cartridges is now recovered with astonishing precision. Your old stock of records of early 1960 or end of 1950 revives with refreshing musicality and high fidelity. By DV/KARAT, all records with no exception sound their best, making it useless for you to care about the recording condition before buying. Then you will find all records since 1960 are more or less hi-fi recording and some of them can outperform today's direct cut records. DV/KARAT widens your choice of music in record, and revives a lot of famous master works with the perfection being thought impossible before. You are wholly rewarded by DV/KARAT and no further worry about cartridges is needed. Only one thing is "listen to music with perfect satisfaction". The best results are available by the use of our DV/505 tone arm and DV/6A or DV/6X stepping up transformer.

Specifications of DV/KARAT and DV/KARAT DIAMOND

	DV/KARAT	DV/KARAT DIAMOND
Type	very small moving coil	←
Output	0.2 mV	←
Frequency Response	20～50,000 Hz	20～70,000 Hz
Lateral Intermodulation (CBS STR112)	−30 dB at +6 dB −20 dB at +15 dB	←
Compliance	15×10^{-6} cm/dyn.	←
Channel Balance	below 1 dB	←
Separation (1 KHz)	over 20 dB	←
Internal Impedance	R=30 ohms L=80 μH	←
Cantilever	0.4×0.4×2.5 mm oblique cut solid ruby	0.4×0.4×2.5 mm oblique cut solid diamond
Armature	1×1×0.5 mm super permalloy	←
Stylus	0.24×2.8 mil line contact low mass diamond	←
Tracking Force	$1.5^{+1.0}_{-0.3}$ gms	←
Vertical Tracking Angle	20°	←
Weight	5.3 gms	←

Dynavector

Dynavector Systems, Ltd.
Acousta Bldg, 8-6 Ginza 3-chome Chuo-ku Tokyo
104 JAPAN
Tel Tokyo (564)4011 Telex J23475 DYNAVEC

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