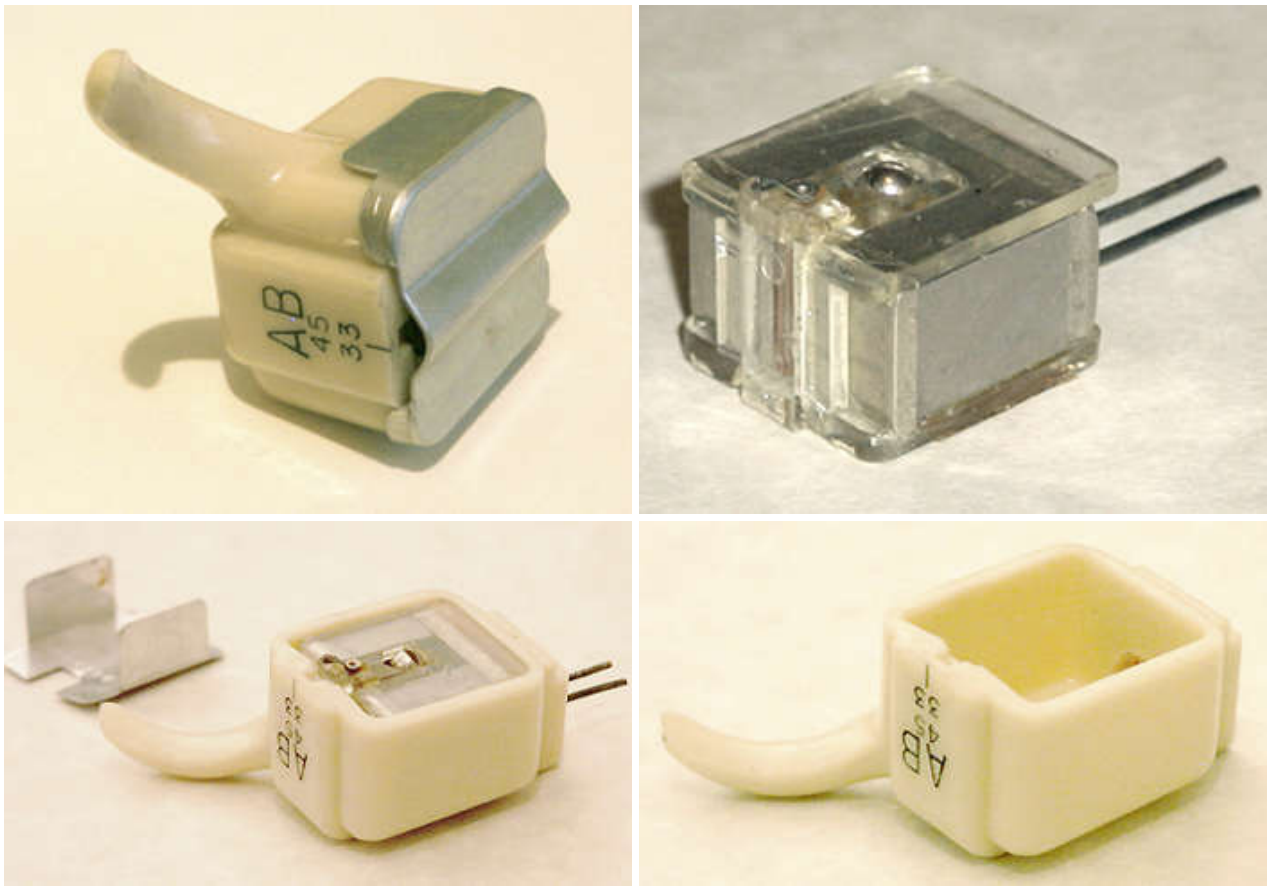
Early cartridges from Ortofon, Garrard Decca London, Tannoy & General Electric

Crystal and Ceramic

In the early days of the Lp, records were played with a crystal or a ceramic pick up (or phono) cartridge. Crystal pick up cartridges have the advantage that they can be connected directly to the line stage of the amplifier. The output is high and no correction is necessary. Just two valves and a high efficiency wide range loudspeaker unit deliver a loud and clear, and dynamic sound, though the high frequencies are not refined. The use of these pick ups was widespread, in spite of the fact that Ortofon had introduced the first moving coil phono cartridge right from the beginning of the Lp era in 1948.

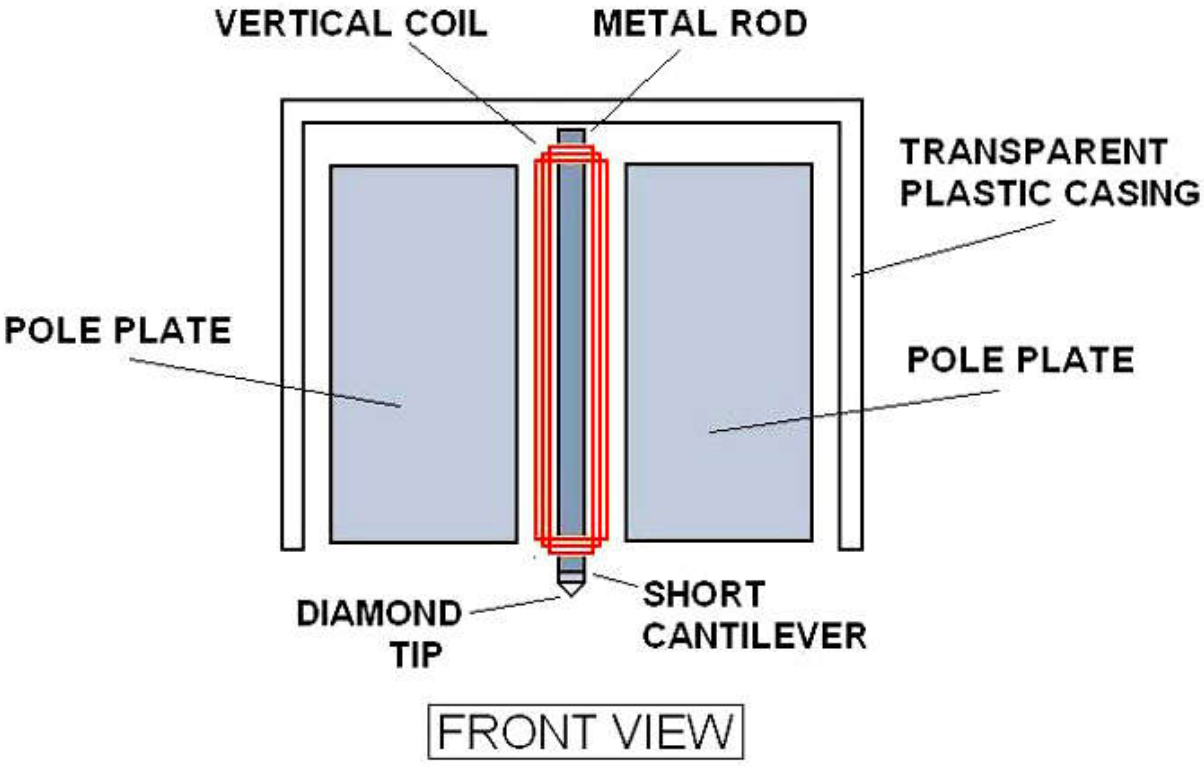
Ortofon Moving Coil Phono Cartridge



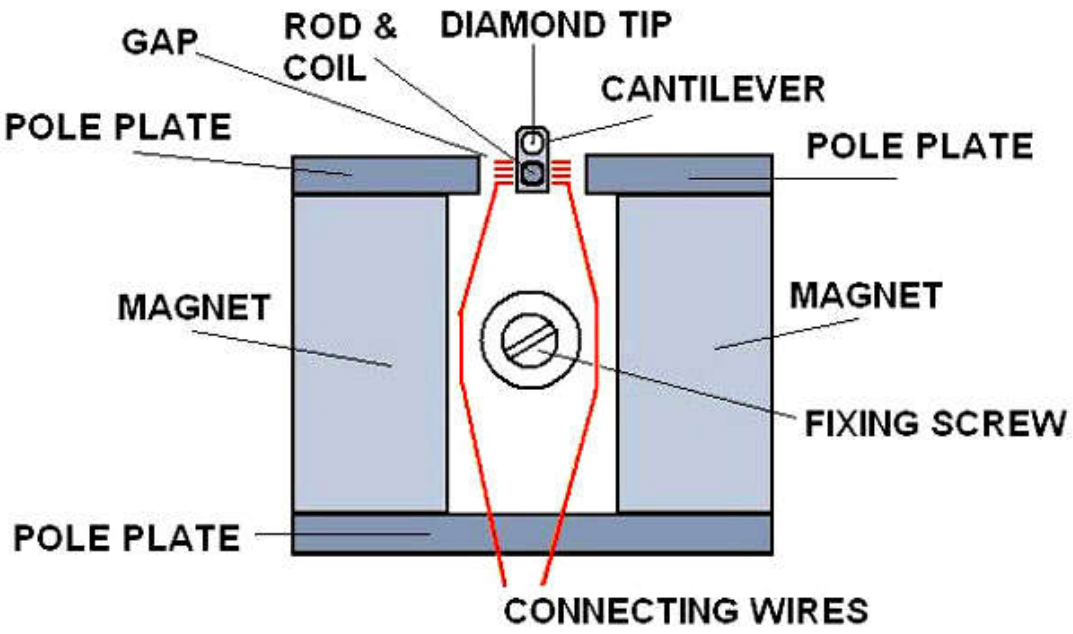
The early Ortofon mono moving coil cartridge was quite a heavy one. It showed already an important trait of the later Ortofon phono cartridges: the short aluminum cantilever.

The advantage of a relatively short cantilever is that the movement of the diamond tip is translated into a signal already very close to the surface of the record. The vibrations do not have to travel through a longer stem (cantilever) which can influence the frequency characteristic of the signal and introduces some distortion. To avoid distortion, most aluminum cantilevers used today have a bend.

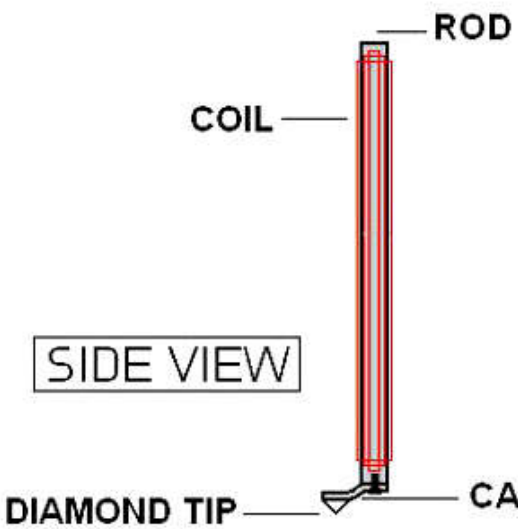
In many modern cartridges and especially the high-end cartridges the cantilever's material is boron or beryllium. The movement of the tip is translated with great accuracy because sound travels very fast in these materials. The main reason being that boron and beryllium are very stiff, their resonance frequencies are in the ultra high region, far from the audio band. Aluminum is a much softer material with a relative lower transmission rate of the sound and it has also some benefits in relation to the midband, but generally the distortion is somewhat higher. Below part of an advertisement for the A and C cartridges in 'The Gramophone' of May 1957 a few months before the stereo LP was introduced.



FRONT VIEW



TOP VIEW



SIDE VIEW

Above: The Principle of the First Ortofon Moving Coil Mono Cartridge of 1948 in all its simplicity.

MODEL M3D

Shure's model M3D tracks with pressures as high as 6 gr. and as low as 3 gr. - picture taken from the April 1966 issue of High Fidelity Magazine.

It is amazing that over a relatively short period of time the further development of the Lp attained an ever increasing quality. The groove guard was introduced in 1954 and better vinyl was gradually made available. The process of galvanizing the lacquer was refined. The dynamics were increased and the frequency band attained greater linearity. The sound was getting more refined.

In this respect the improvement of the tape recorder and the development of better cutter heads, lathes and lacquers was crucial for recordings to have a higher fidelity.

Already five years after the introduction of the Lp format, the first **commercial stereo recordings** were made by Remington Records Inc. in 1953 and RCA followed the next year. These could have been marketed then if the phongraph playback equipment would have been available to the general public. However, there was the stereo tape recorder. The stereo disc was presented and made available to the record buying public in September 1958 for the first time.

The first companies to manufacture a moving magnet cartridge were

Elac (Germany), AKG (Austria) and Shure Brothers (USA).

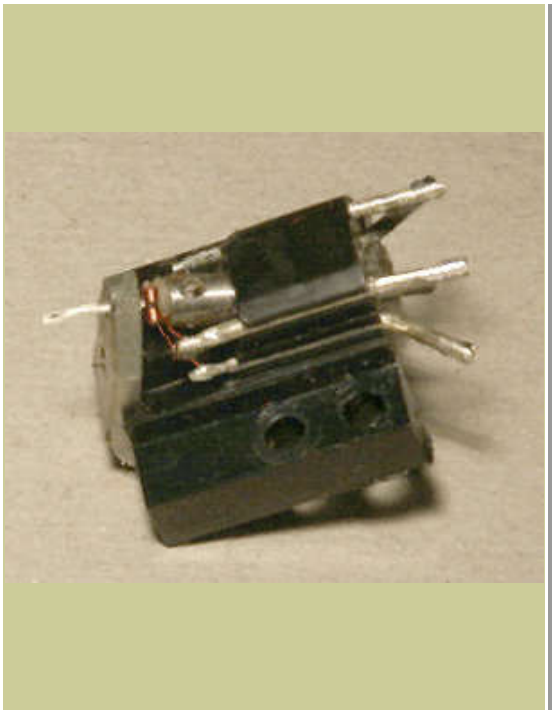
NOTE: Some 10 years ago I had a short correspondence with a Dutchman who migrated to the US in the mid 1950s. He had designed a moving magnet cartridge that was patented, but Philips did not want to manufacture cartridges along this priciple as they had their gramophone players equiped with ceramic transducers. Then - according to this former Philips-engineer - he left the company and migrated to the USA (as many Dutch people did at the time). Then Shure studied his patented design, made a few alterations to avoid patent infringement and started producing moving magnet cartridges.

In 1957 Shure Brothers introduced their first M1 Studio Dynetic cartridge. When the stereo phonograph record was launched, Shure came up with the M3D Stereo Dynetic phonograph cartridge. This development and the introduction of the SME pick up arm designed and manufactured in the UK greatly have contributed to the acceptance and the success of the stereo Lp, even though the catalogs still listed the mono equivalents of new stereo recordings and still many mono records were sold. Shure developped and improved their cartridges to an extreme level. From the M3D they developped M-44, M-77, and the various V15 cartridges. This is what John Borwick in The Gramophone of November 1969 had to say when he was reviewing the Shure M75 II series of cartridges:

"Shure Brothers Inc. includes some of the top audio brains anywhere. Their work on pickup cartridges has brought listening pleasure to countless music lovers and given their competitors a difficult challenge.
Very soon after stereo records came on the scene, the Shure M3DM was launched as an early example of the moving magnet principle adapted to twin channel 45°/45° reproduction. How right this basic design was can be judged by the M3DM's continued popularity right up to the present day and by the family of a dozen or so more sophisticated Shure cartridges which have grown up to match the upward trends in pickup arm, amplifier and speaker performance."

For a long time alreaqdy the crystal pick up was only used in small budget systems and in portable gramophones. Popular brands of crystal pick ups were **Acos** and **Ronette**.
Other manufacturers too developed all sorts and types of moving magnet cartridges. There are many more famous names like Elac, Pickering, Goldring and Stanton. **Ortofon** introduced their SPU cartridges (stereo) and their top of the line arms and step up transformers to match these moving coil designs.

Ortofon SPU Cartridge



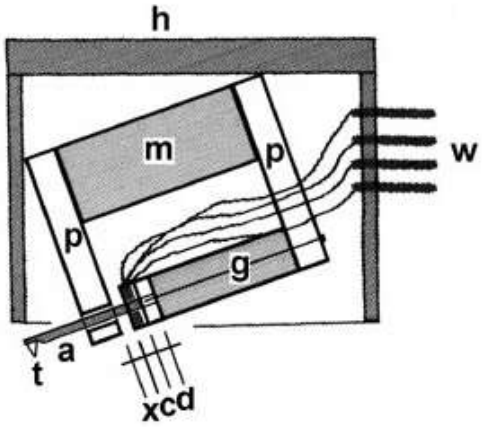
At left you see the innards of a very old Ortofon SPU cartridge from the early days of stereo.
At first inspection it seemed that someone had soldered the connecting leads to the four pins at the back instead of using clips. On top of that the pins had come loose and could be turned very easily.
I had to take off the housing to check if the wires of the coils were still connected to the pins inside the cartridge. They were.
Although the rule is "Never solder connecting wires to the pins of a cartridge whatever the type", in the case of the SPU soldering was done in the factory for connecting the output of the cartridge directly to the small step up transformer which was placed in the headshell right behind the cartridge. The lower left image shows the cartridge and the step up transformer. (Picture courtesy Arne, USA.)

The Moving Coil Principle

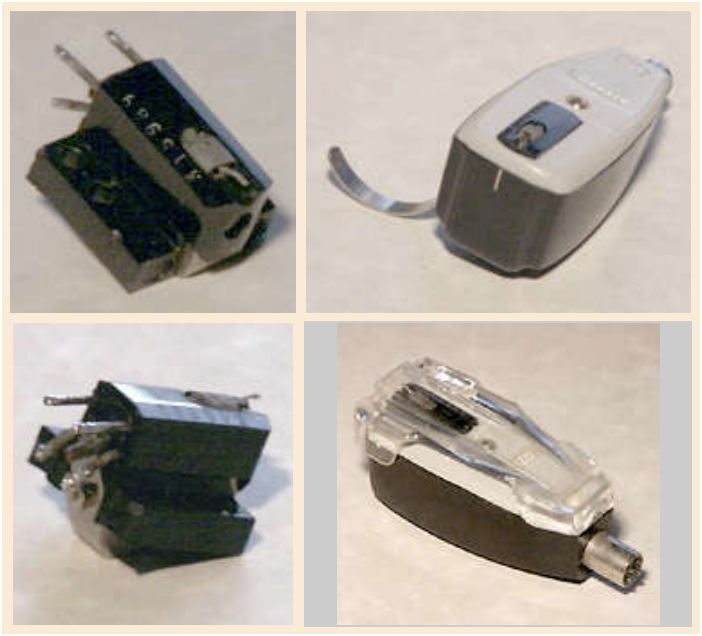
The drawing shows the principle of the cartridge: coils moving in a magnetic field. All parts and also the arrangement (the topology) are of course of great importance. They determine the quality of the signal being picked up: strength, frequency characteristic, harmonious build up, and the level of distortion.

The aim of course is to retrieve the maximum signal from the groove by optimizing the mechanical technique (the functioning) and by the application of specific materials for the various components: coil wire, core material, magnetic material, rubber damper, cantilever, diamond tip, connecting wires, cartridge housing, and the distances between the individual parts and the arrangement (topology).

All these were as important in the early days as today where cartridge builders have chosen different materials and maybe a slightly different topology, but the main principle developed by Ortofon is still their starting point.



m = magnet
p = pole piece
a = armature (cantilever)
x = distance pole piece-coils
c = coils
d = damping rubber
g = piano wire
w = pins/cartridge wiring
h = housing
t = diamond tip



Shown here is a cartridge and when mounted in its shell it has a light gray, plastic cover with an opening which fits around the protruding coil assembly and the cantilever. Before storing it in the beautiful red box, a transparent cover protects the needle assembly of the cartridge.

Ortfon SL15/SL-15 Cartridge

Ortofon SL 15 ELL is a further development of the Ortofon SL15 cartridge from around 1968 and had a beautiful step up transformer to match the impedance of the cartridge (2 Ohms) and the output impedance of 15 kOhm to connect perfectly well to the input impedance (load impedance) of 47 kOhm of the (pre-)amplifier. (These two images courtesy Don Sellers, USA).

These cartridges were replaced by the SL15, SQ 15 in the days of Quadro, and later by MC20 and MC10, before the 2000 and 7000 were introduced. Below is the paper with the most important specs. Significant is that the electrodynamic system has a "flat" (velocity versus frequency) response, irrespective of the load.

ORTOFON 2-15K PLUG-IN TRANSFORMER

Due to the low impedance and output voltages of some cartridges – such as the SL-15 – it is often necessary to employ a transformer. Ortofon offers a twin-transformer (for stereo use) with cables and plugs which can be plugged in between the normal connecting cables and standard amplifier input (47000 ohms). The output impedance of the transformer is 15000 ohms. However, this does not mean that the amplifier input impedance has to be 15 k ohms, too. The electrodynamic system has a "flat" (velocity verus frequency) response irrespective of the load. The specifications of this transformer are: input impedance: 2 ohms. Output impedance: 15000 ohms. Load impedance: 47 K ohms. Frequency response: 10 to 40,000 Hz.

The simplest of Ortofon arms: short effective length, heavy counterweight to accomodate the headshell with cartridge and heavy transformer incorporated, rather soft plastic shell, no arm lift and no bias compensation.

For the later SL-15E Ortofon developped a smaller and more affordable transformer, type STM 72 with a frequency range from 20 - 50.000 Hz., pick up impedance 2 Ohms, and load impedance 10 - 15 kOhm. The coils were double screened with mu-metal. This transformer could also be used with the MC20 and MC10.

Garrard GMC5 Cartridge

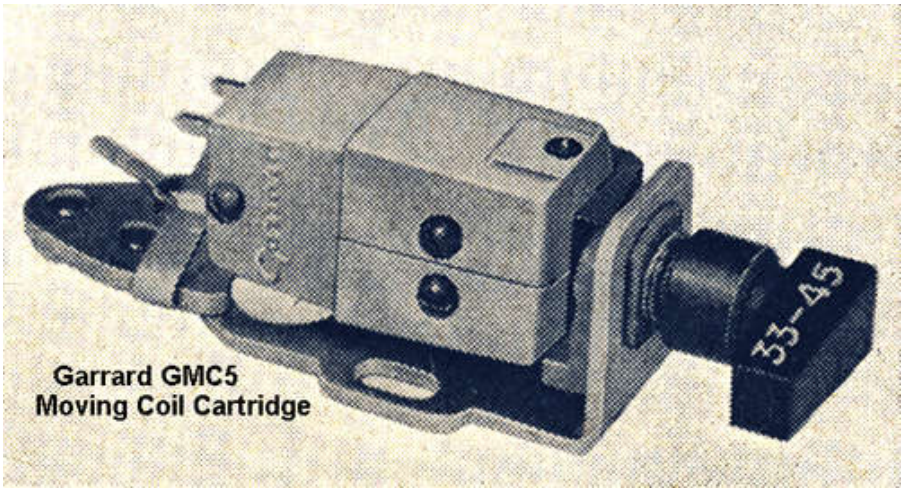
Although Garrard was a big name in turntables, the company never made a great effort to conquer the hearts of the music lovers with a cartridge line. And if they manufactured a few cartridges or had a few made by other manufacturers and put their name on them, the impression is that this concerned ceramic or crystal pick ups.

Some may be surprised to know that Garrard did market a moving coil design, GMC5. It was a mono turnover design capable of reading 78 rpm shellac and vinyl Lp records. The frequency response was 20 to 16.000 Hz. The cartridge was meant for mounting in the TPA-10 transcription arm. The low compliance of 6 x 10-6 cm/dyne was of course in accordance with the heavy mass of that arm. This combination made it necessary to apply a down force of 5 gr. The transformer to which the GMC5 was to be connected should have a load impedance of 500 Ohm.

The GMC5 was reviewed in conjunction with the TPA10 tonearm in the May 1957 issue of the monthly magazine "The Gramophone". The reviewer was Percy Wilson. This is what he said about the GMC5:

"This is virtually two complete moving coil pickups placed back to back as to give a turnover arrangement. Each moving coil is operated by its stylus through a cantilever which has appreciable vertical compliance to deal with "pinch effect" and avoid "needle chatter".

Percy Wilson praised the skill of the engineers who succeeded in constructing this turnover design, but saw also the downside of it: a heavy cartridge.



2. *The Moving Coil Cartridge*, GMC5 (Price £7 7s. 6d. plus £2 17s. 7d. P.T.)

Specification:

Response: 20-16,000 c/s constant velocity on microgroove records.
Compliance: Better than 6 x 10^{-6} cm/dyne.
Stylus Pressure: 5 grms.
Transformer: TPI, of hum-bucking construction in mumetal screening box; primary centre tapped to earth.
Output from Transformer: 8 mV at 1.2 cm/sec rms.
Load across Transformer: 0.5 megohm minimum.
Styli: Diamond 1 mil for microgroove. Sapphire 2½ mils for coarse groove.

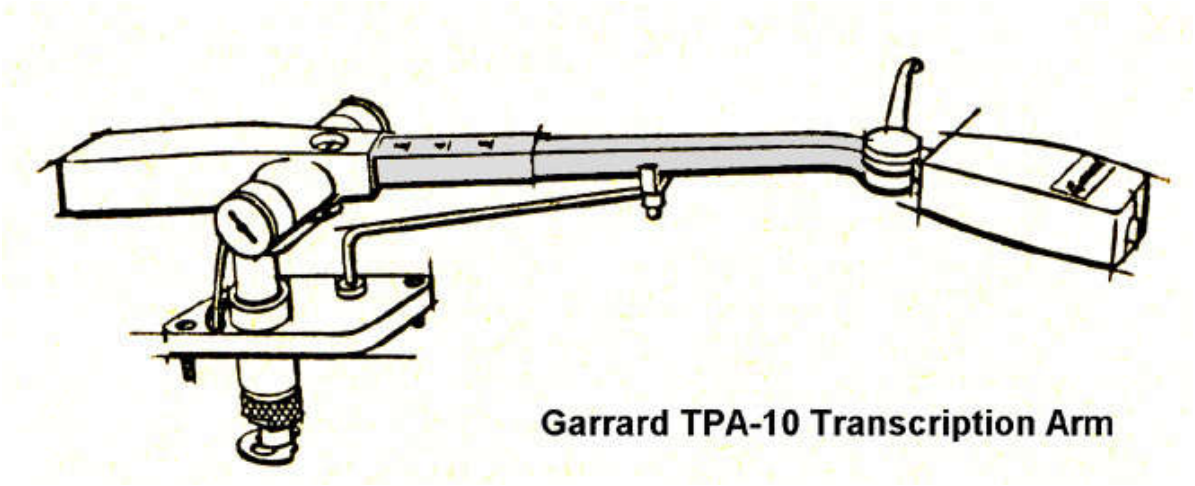
Garrard TPA 12 Transcription Arm

This is the Garrard TPA12 tonearm which adorns the **4HF and 5HF turntables and grammophones** and the Type A record changer as well. Stylus pressure was adjusted by turning a wheel positioned at the rear end of the arm. In other versions adjustment was done by turning a bolt instead of a wheel.

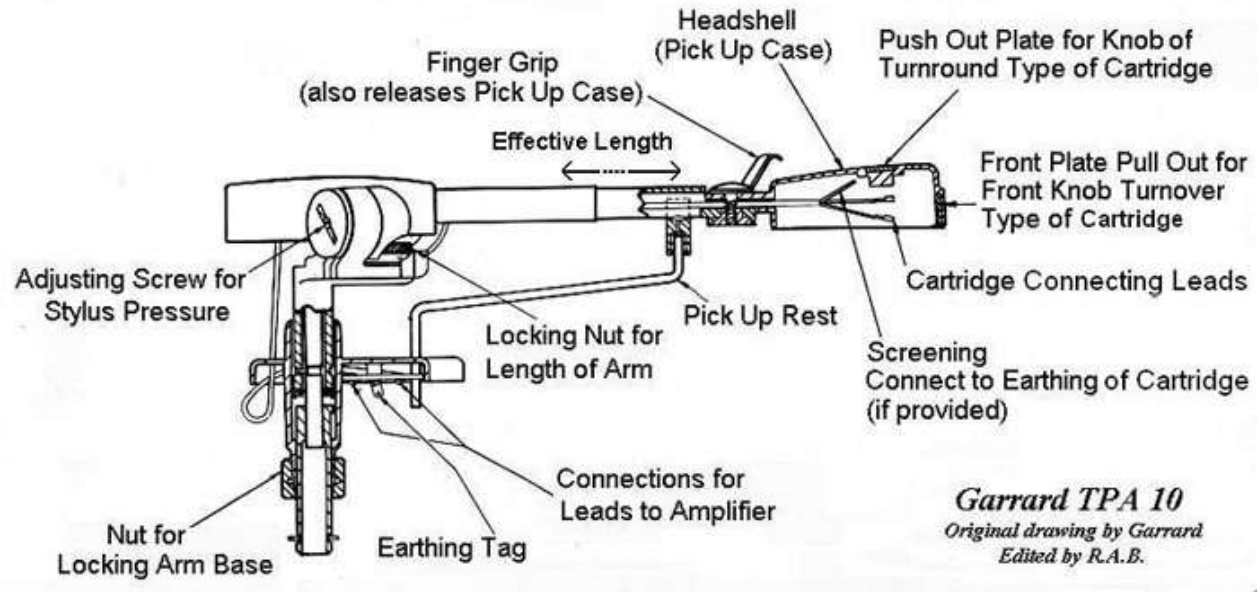
Garrard TPA 10 Transcription Arm

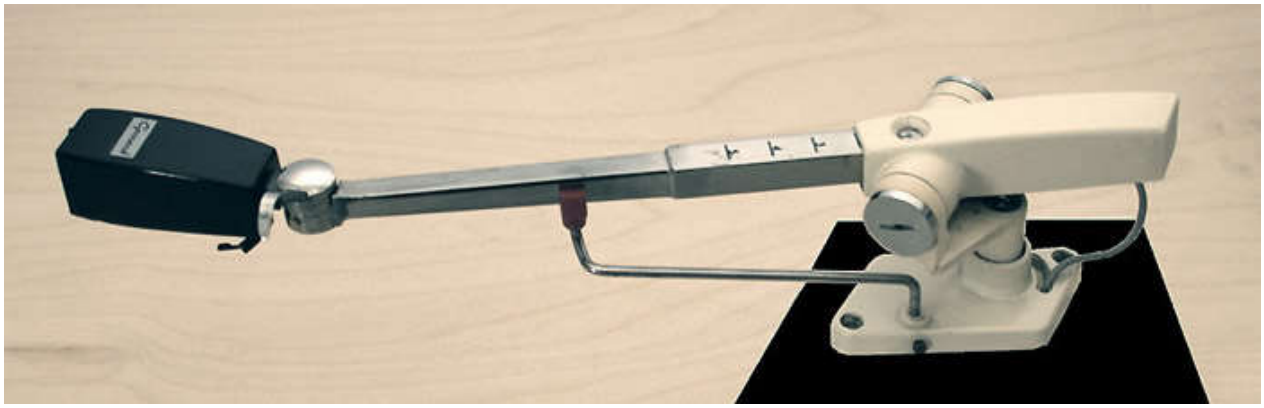
The TPA 10 was a more sophisticated arm, although it too was of the rather heavy type. This most certainly had to do with Garrard's own GMC cartridge and probably also with the heavier Decca and Tannoy cartridges which were in use in Geat Britain at the time. The TPA-10 could be changed in length and the offset angle could be adjusted accordingly. This in order to achieve the least lateral tracking error. Unscrewing and tightening the large bolt made this possible. This adjustment was necessary if the (effective) length of the arm was changed. Only of course if the turntable base did permit the positioning of the arm's pivot somewhat further away from the spindle. This arm was specifically designed for the Garrard 301 turntable.

Note: Stylus pressure was adjusted by turning a small wheel (screw) positioned on the inside of the arm base, rather than by turning a wheel as in the case of the simpler TPA-12. When the Garrard 401 motor unit was introduced in 1964, six years into the stereo era, then other arms, like SME and Ortofon, were used.



Garrard TPA-10 Transcription Arm



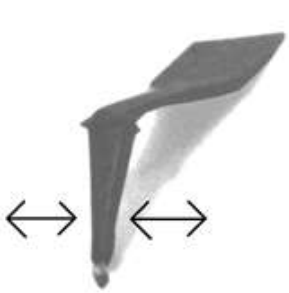


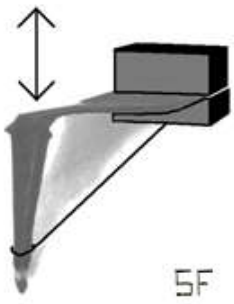
DECCA Moving Iron Pick Up Cartridge

In the early stereo days, some odd, but very remarkable designs were introduced. One of these were the moving iron cartridges made by Decca Special Products. The design was derived from the earlier cartridges in the Series 4, developed in the mono era.
The first stereo cartridges were designed especially for playing the new Decca Full Frequency Stereo Sound recordings (FFSS). The later Garrott versions were Deccas, modified by the Garrot Brothers in Australia. Aalt Jouk van den Hul re-tipped several Decca Gold cartridges with a long, nude version of the special Van Den Hul tip.

Different

The engineers of Decca followed a completely different track than Ortofon (MC), Shure (MM) and Garrard of course. Knowing that the signal will deteriorate somewhat if a long cantilever is used, they devised a way to practically retrieve the signal just above the groove. To achieve this, the Decca engineers positioned the generator (coils and magnets) as close to the surface of the record as possible, only leaving the necessary room for the diamond tip, but not more than approximately one millimeter but always in such a way to prevent the housing from touching the groove guard or the record's surface.
The first cartridges were mono cartridges with one coil.





Philosophy

Did Ortofon connect a long vertical coil to the cantilever to move in between the poles of a magnet, and did Shure connect a tiny magnet to the end of the cantilever to move in between coils, Decca's men choose as generator a piece of iron to move between magnetic poles close to or within a fixed coil. They choose for this concept right from the start when they designed their first **ffss** cartridge.

They gave the iron piece an angled shape. Slight flexing was possible in both the horizontal and the vertical plane. By clamping the rear end in a block, it stayed

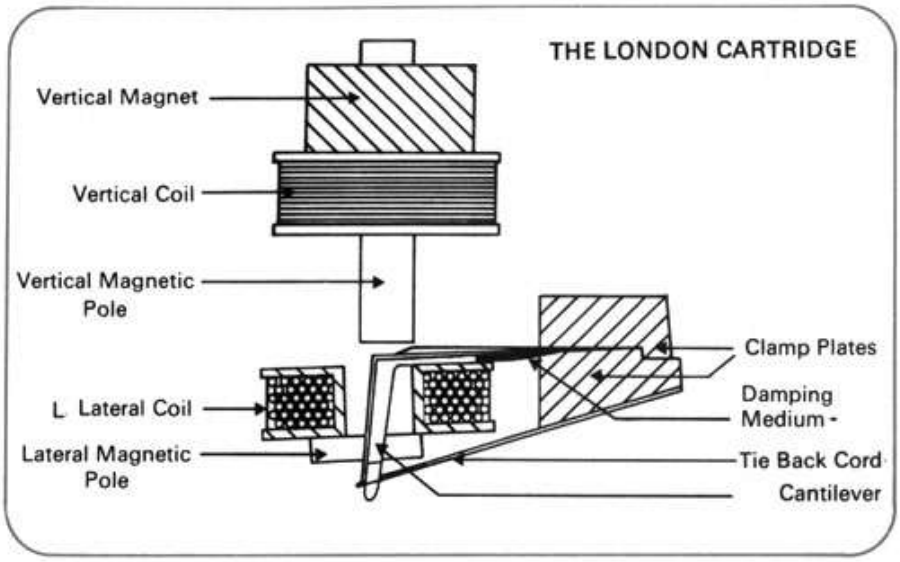
firmly in place to guarantee a correct azimuth at all instances (if the cartridge had been precisely adjusted in the arm in the first place).
In that way they avoided the small piece of rubber that in MM and MC cartridges constitutes the pivot and at the same time functions as a damper to control the movements and resonances of the cantilever and its tip and of the coils wound on the tiny core. It is this rubber that greatly influences the signal and is responsible for a certain weakness in the lower mid region. If this small piece of rubber can be left out, than the signal can be as pure as it possibly can be.

Note: There is just a very thin piece of rubber glued on the horizontal part of the iron. This is to prevent that the tie back cord pulls the iron against the horizontal coil when the diamond tip is not in the groove, i.c. is not scanning. But it is not altering or deteriorating the signal.
The early Deccas generated some hum if the coils are close to iron platters and in case the motors were not well screened off.
The Decca engineers did master this problem. They also looked for better magnetic materials and they made the armature extremely stable by forming it and cooling it at - 196 degrees Celsius. They even lowered the weight of the cartridge to a mere 4 grams, which extremely low.

Hysteresis

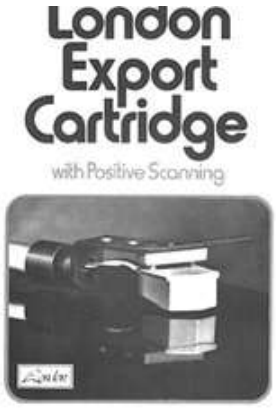
There is a second aspect of great importance. The core of the coils in a Moving Coil Cartridge should be very light. Problems occur when thin and light pieces of metal are used for the core. The downside of this is that it will have hysteresis, which means that the coil interacts with the core and will become a motor with a changing hysteresis and the subsequent distortion (though minute) which has a changing and unwanted effect on the signal. Hence in a few designs of some manufacturers a tiny plastic cross was used on which the coil wire was wound. Cartridges with moving magnets do not have this problem but show other weak points. A moving iron cartridge just makes use of the effect which a piece of iron in a coil has.

The Decca London Configuration

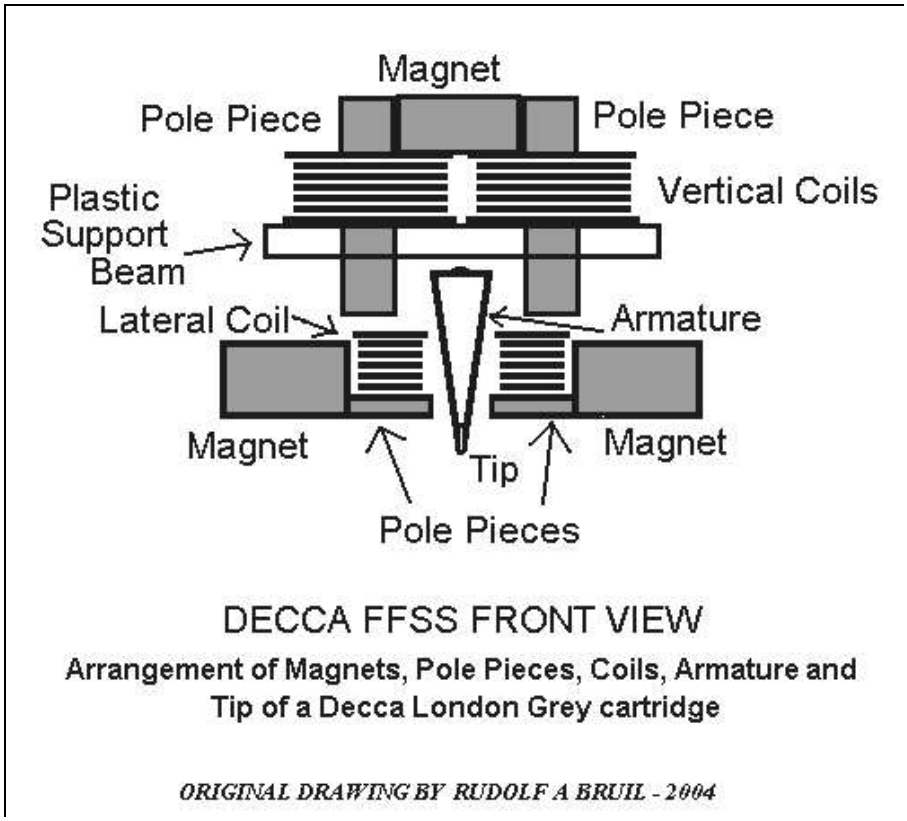


The Decca London

The design of the Full Frequency Stereo Sound (ffss) cartridge uses two pairs of magnets and three coils. One magnet for the pole pieces of the **two 'vertical'**



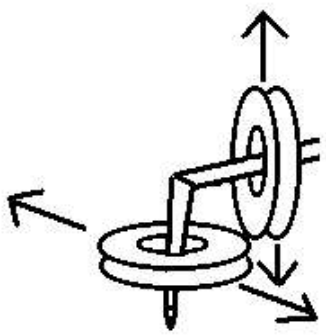
coils (the drawing supplied by Decca shows only one coil). And there are magnets placed left and right of the **single lateral coil** for generating the lateral movement of the armature.
For the lateral movement the pole pieces of the horizontal magnets were placed left and right of the tiny piece of iron to which end the diamond tip was connected.
The iron was placed inside the lateral coil. So the system becomes a motor. This coil was placed right above the magnet poles.



DECCA FFSS FRONT VIEW

Arrangement of Magnets, Pole Pieces, Coils, Armature and Tip of a Decca London Grey cartridge

ORIGINAL DRAWING BY RUDOLF A BRUIL - 2004



It would have been theoretically logical if for the vertical movement just one coil would have been used and placed around the horizontal part of the bent iron cantilever which is parallel to the record's surface. This would mean that the coil with a magnet had to be positioned farther away and closer to the clamp holding the garrote in order to leave ample room for the lateral coils. In that configuration the parallel part of the iron needed to be much longer, in fact too long. The Positive Scanning (as the Decca engineers called the working of their design) would not have been possible.

Furthermore some lateral movement or a bending mode could have been the result and would have deteriorated the signal. There would be a delay in time also. And, the movement of the iron piece is there at a minimum. Unless, of course, very tiny coils in conjunction with a step up device would be used.

No, the best solution was to position the magnet and coils which generate

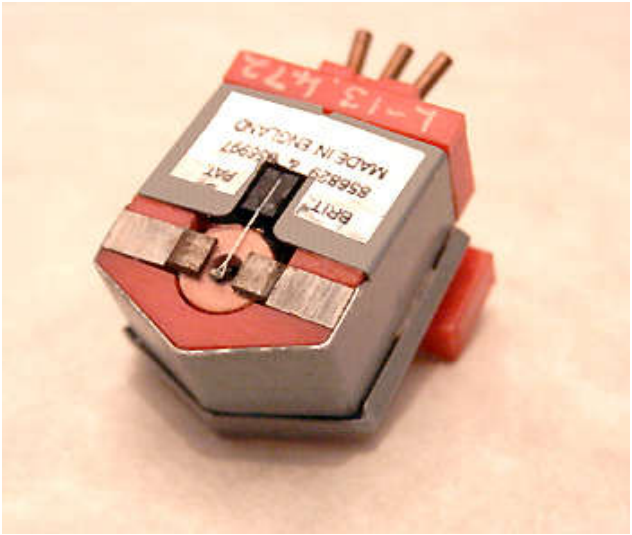
the vertical movement, right above the angle of the iron piece which serves also as cantilever. At that point the vertical movement is the largest. There was no other way for detecting the vertical variations as close to the record's surface as possible.

When playing a record the horizontal and vertical movements continuously vary the gaps and thus generate the signals. The lateral (horizontal) movement is a **torsional movement** and the vertical movement is a **bending movement**.

The configuration 3 coils made it necessary to derive the stereo signal by adding and subtracting the signals. Even then the minute changes induced by both the horizontal and vertical movements of the iron part deliver a strong signal due to the large coils and strong magnets.
In order to keep the diamond tip in place (so it could not move forward) a tie back cord (garrote) is used.

The result is a clear and very realistic sound reproduction as no other design can deliver. The only drawback is the low vertical compliance which necessitated a downforce of up to 3 gr. in the Decca Blue, and in the earliest models even more downforce was required.

Later the Mark V and VI, the Maroon, the Gold and Super Gold were introduced when the functioning of the system was further improved by reducing the mass of the moving iron so it would be more flexible laterally and also somewhat vertically (higher compliance) without impairing its stiffness. Also new magnetic materials were used. This resulted in the possibility of incorporating elliptical styli and in the beginning of the nineteen eighties of fine line diamond tips. The outcome: an extended frequency band and the downforce could be reduced to 1.7 to 1.9 gr.
All Decca cartridges can be re-tipped Services are offered by The Cartridge Man in Great Britain and by Aalt Jouk van den Hul in the Netherlands.



London Export

Output		7½mVs for 5cms
Frequency range		20 Hz to 20 KHz ± 2dB
Stylus		Diamond
Stylus radius		.0006/7"
Vertical tracking angle		15°
Compliance	Lateral:	12 x 10^{-6}cm/dyne
	Vertical:	5 x 10^{-6}cm/dyne
Balance		Within 1 dB
Inductance		130mH per channel
DC resistance		4400 ohms per channel
Tip mass		less than 1 milligrams
Playing weight		2 to 3 grams
		Recommended 3 grams

DECCA LONDON EXPORT
Output: 7.5 mV per channel.
Frequency Response: 20 - 20.000 Hz. +/- 2 dB
Stylus Material: Diamond
Stylus Radius: 0.0006/7"
Vertical Tracking Angle: 15 degr.
Compliance Lateral: 12 x 10-6

During the manufacture of whatever component, be it amplifier, loudspeaker, DA-converter or you name it, there are always slight differences between the ready products. For cartridges these differences are more or less noticeable in the linearity of the frequency curve and the values for crosstalk

cm/dyne
Compliance Vertical: 5 x 10-6 cm/dyne.
Channel Balance: within 1 dB
Inductance: 130 mH.
DC Resistance: 4400 Ohms per Channel.
Tip Mass: less than 1 milligram.
Playing Weight: 2 to 3 grams. Recommended 3 grams.

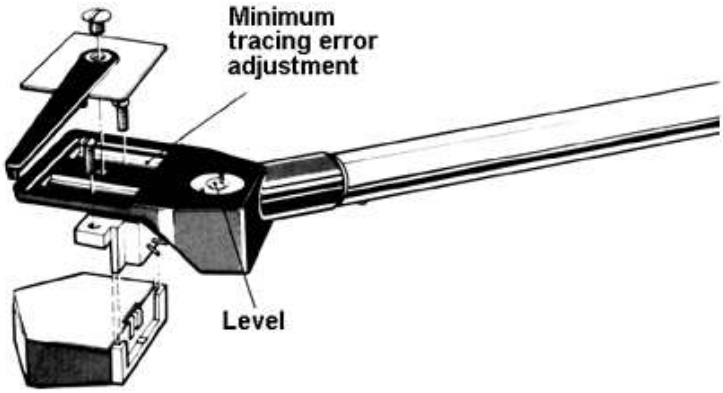
(channel seperation). The Decca London Export was in fact a Decca London cartridge but had better specifications. The frequency curve of an "ordinary" London was 20 - 20.000 Hz. +/- 6 dB, while the Export model's curve was better than +/- 3 (generally +/- 2 dB).

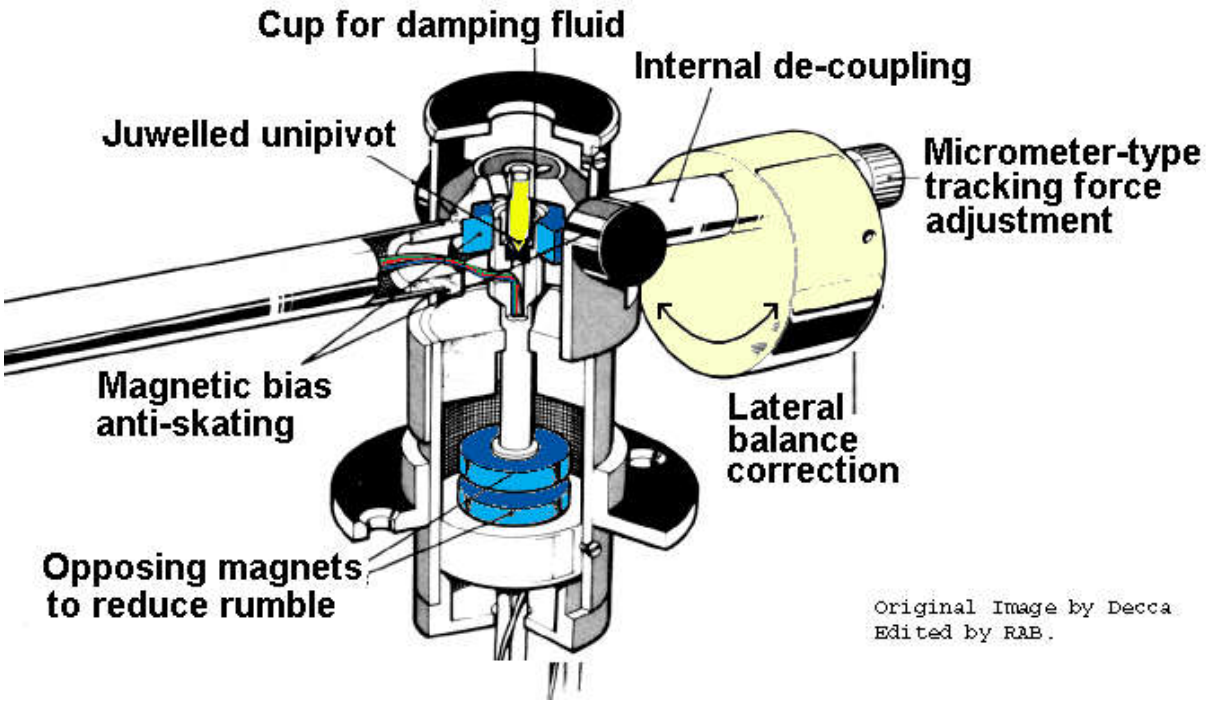
Tolerances and Positive Scanning

When manufacturing cartridges, tolerances are relatively large because winding the coils, manufacturing the tiny parts and components are all done by hand. That is why there can be some differences between two cartridges of the same type. Manufacturers often select from a production run those cartridges which answer to the tolerances of a specific checklist. From the same production run various categories can be selected which will fall into specific price brackets. Tolerances with Deccas are somewhat larger. There can be minute differences between tips and the moving iron.

Also the adjustment of the Vertical Tracking Angle can vary slightly from one cartridge to another. But this does not impair the working of the Positive Scanning configuration. A somewhat longer or shorter diamond tip does not influence the signal. Even a higher tip mass does not change the excellent rise time which is always better than the design with a long aluminum cantilever.
With the older Decca cartridges you can be sure to have a high output signal of 7.5 mV. The later models have less output all depending on the coils, shape of tip and magnets used.

DECCA International Arm





Decca International arm

The Decca engineers designed a tone arm to match the Decca London cartridges.
It has specific features:

1. Frictionless unipivot with magnetic bearing. This reduces rumble. This was probably devised with the turntables of those days in mind: Garrard 301, Garrard 401, and Lenco/Goldring.

2. Optional fluid damping. If it is necessary to dampen the fundamental resonance of the cartridge-arm combination, the appropriate viscosity can be selected.

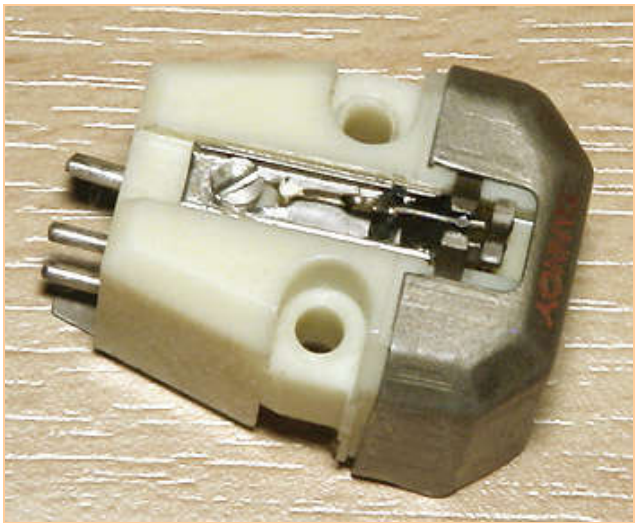
3. Magnetic Bias Adjustment. This design (later followed by other manufacturers) further isolates the arm completely. The arm is free as opposed to those arms which use threads and small weights.

4. Complementing sound pattern. As the review in Hi-Fi Choice showed, the measured frequency characteristic of the arm is different from most arms. This sound characteristic of the arm compensates for the frequency characteristic of the Decca cartridges. The arm is best suitable for the older Blue and Gray, MKV, and Mk VI, respectively. For the later Decca Gold and Maroon some prefer the Hadcock arm. The Decca International arm is not suitable for most non-Decca cartridges as trials with the Denon DL-103 showed. But then the silicon damping fluid was not removed.

5. Precise leveling of cartridge (VTA and Azimuth) and balance. The arm can be adjusted to very a high and very fine level to retrieve the complete signal out of the record groove.
In general the use of magnets for the arm bearing is not preferred by all designers. They do not go for rubber insulators either, for threads and weights in bearings, or other ways of de-coupling the pivot with the aid of a magnet. They prefer the "grounding" of the arm to the chassis or plinth right at its base.

TANNOY Variable Reluctance Phono Cartridge

A peculiar design was the Tannoy VariTwin (Vari Twin) or Variluctance Phono Cartridge which of course used the same principle as the Decca ffss pick up. The VariTwin was introduced in 1959 and it was followed by the Mk2 in 1965. For this cartridge Tannoy also had special styli for 78 RPM records with a specific shape and mass. The styli were easily exchangeable by loosening and fixing a screw at the end of the cartridge.
The Tannoy VariTwin is a heavy cartridge. It weighs some 12.5 gr. The simply stenciled leaflet does not state the compliance. It states the optimal capacitance of the 47 kOhm entrance of the phono stage, which is 150 pf. and keeps the resonance at 20 kHz. well under control. Frequency response is 30 to 15.000 Hz. The downforce was 4 gr. or less. In the mono days heavy, thick records were pressed which could sustain up to 10 gr. downforce.



The cantilever is a long piece of metal that is fixed at one end with a bolt. On the other end figures a substantial stylus which asks for 4 gr. of playing weight. But since records in the mono era and in the first ten years of stereo were pressed from a harder and stronger vinyl, such weights were no problem. The Tannoy stylus could easily be exchanged for a new one or a special stylus for playing 78 RPM shellac records.
As in the case of the Deccas with their Positive Scanning ability, the advantage of the Tannoy design also the advantage of reading and translating the signal as close to the groove as possible. Here also the long cantilever which is the drawback of most modern cartridges is omitted.
The innards of the cartridge are not explained in the leaflet. And since I am reluctant to open the cartridge, the exact configuration and functioning remains a mystery.

Frequency Response: 30 - 15.000 Hz. +/- 1.5 dB

Output: 7 mV per channel.
Load: 50 kOhm minimum, 100 kOhm recommended.
Inductance: 350 mH.
Maximum Termination Capacity: 150 pF (correcting at 20 kHz.)
Stylus Material: Diamond
Stylus Dimensions: 0.0007 Compatible (Standard), 0.0005 Stereo only (to special order)
Tracking Pressure (Down Force): 4 grm. or less.
Standard 1/2 Inch Fixing Holes.

THE TANNOY 'VARI-TWIN' MK.II MAGNETIC STEREO CARTRIDGE.

Technical Specification.

FREQUENCY RESPONSE:	30 c.p.s. - 15,000 c.p.s. ± 1.5 dB.
OUTPUT:	7 m.v. per channel.
TERMINATION:	50 k min. 100 k. recommended.
INDUCTANCE:	350 mH.
MAX. TERMINATION CAPACITY:	150 pfs (tunes at 20 kc.)
STYLUS MATERIAL:	Diamond.
STYLUS DIMENSIONS:	0.0007 Compatible (standard) 0.0005 Stereo only (to special order).
TRACKING PRESSURE:	4 grms. or less.

STANDARD ½" FIXING CENTRES.

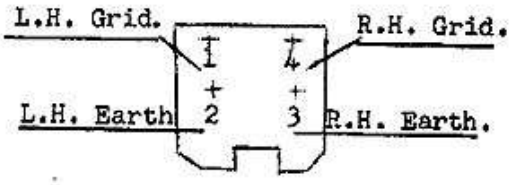
Fitting to an Arm.

The Cartridge may be mounted in most standard shells or arms. Due to the low tracking weight (3-4 gm.) the arm used must have absolute freedom of lateral and vertical movement with no bearing vibration or friction from leads etc. The tone arms of commercial players and record changers are not recommended.

NOTE:- Do not solder direct to the connecting pins. The slide-on tags should be removed for soldering etc.

Connections.

STEREO:-



MONAURAL.

Parallel left and right coils to cancel vertical generation as follows:-

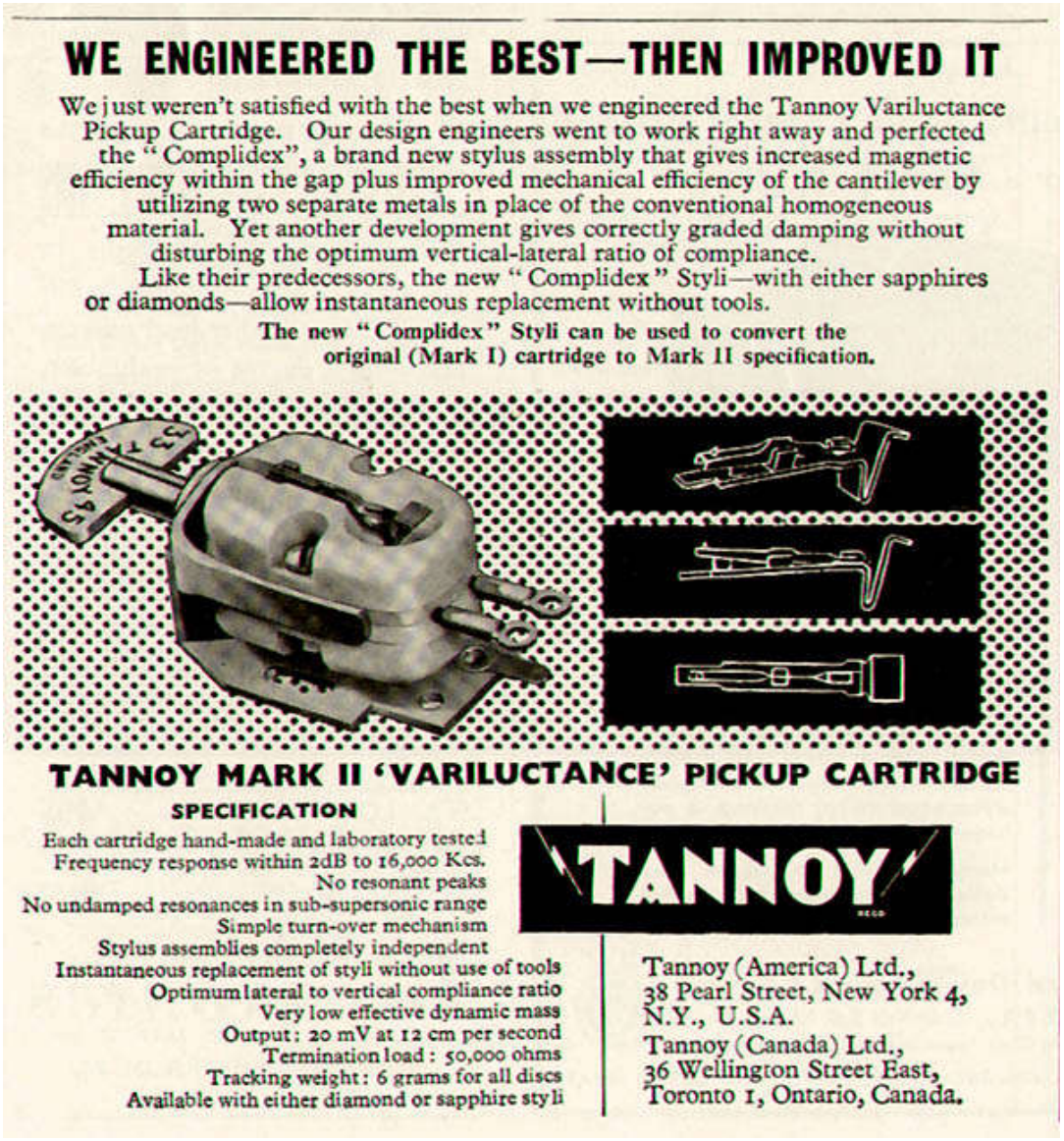
Join pins 1 and 4 for common 'hot' lead.
Join pins 2 and 3 for common earth (shield).

Stylus Changing.

First note the exact position of the existing stylus, then remove the fixing screw and slide back, and remove the stylus carrier. The new carrier can then be fitted and slid forward into position. IT IS IMPORTANT to ensure that the front damping block on the carrier is in contect with the lower set of poles and that after tightening the screw, the actual stylus tip is centrally positioned between the pole pieces.

The Trademark 'VARI-TWIN' is registered and the Cartridge is covered by provisional patents.

Tannoy also manufactured a turnover model of the Variluctance cartridge with "Complidex" stylus assembly.



General Electric: Record Filter, Clip-In-Tip, Al-500 Arm

In the US it was **General Electric** who produced a similar cartridge with the easy **G-E Clip-In-Tip** which makes stylus changes effortless. They also manufactured a tonearm with the appropriate arm mass. The low value for compliance needs a relative heavy arm. That is why "bass distortion disappears" - as the copy in this section of an advertisment from High Fidelity of October 1955 says.

New General Electric Components Insure Best Performance At Three "Critical Quality" Check Points

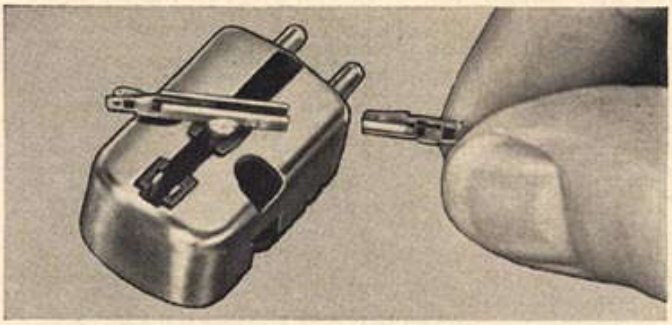
AT THE RECORD . . . AT THE STYLUS . . . AT THE TONE ARM

Here are three new ways to improve the "Critical Quality" of your hi-fi system—*by as much as 25%*. These new General Electric Hi-Fi components improve your record quality, tone arm balance, and cartridge and stylus fidelity.

Insure a perfect performance from *every* selection you play. Enjoy all the lilting highs and bass crescendos you strive to obtain in high fidelity listening. *Insist* on General Electric High Fidelity components. See, but most important, *listen*, to these "Critical Quality" G-E Hi-Fi components at your nearest General Electric Hi-Fi salon.

AT THE RECORD . . .

The G-E 3-Way Record Filter—three filter controls suppress turntable rumble and vibration, reduce record scratch and high frequency distortion, provide complete six-position compensator selection. Regain brilliance from even your oldest recordings.

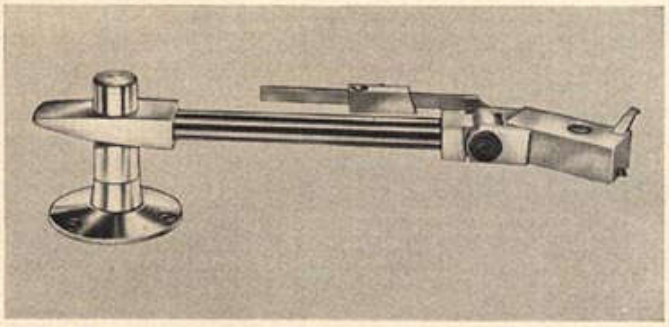


AT THE STYLUS . . .

G-E Clip-In-Tip Variable Reluctance Cartridge—Exclusive G-E Clip-In-Tip makes stylus changes effortless. Protects recordings, faithfully reproduces a full range of sound. Here's the same cartridge and styli used by virtually all professional broadcasters. Insist on the genuine G-E.

AT THE TONE ARM . . .

G-E AI-500 Baton Tone Arm—for a new emphasis on pickup balance with no perceptible torsional resonance. Ideal response from 20 cycles up—tone arm bass distortion disappears. Your assurance of even stylus wear—longer record collection "life."



New Free Booklet. For more information about high fidelity and G-E Hi-Fi components see your hi-fi dealer, or write: *General Electric Co., Radio & TV Dept., Section R54105, Electronics Park, Syracuse, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Next to a Linn LP12 with a Lyra Delos cartridge, Jean-Paul Ditmarsch from Amsterdam in the Netherlands, plays Mono LP records from the 1950s with a General Electric VRII cartridge mounted in an original Thorens arm on a Thorens TD135 turntable. The General Electric VRII gives a very good reproduction of the mid band and pleasant high frequencies.